STIMULATING REFLECTION AND CATALYSING CHANGE IN CHEMISTRY EDUCATION
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Stimulating Reflection and Catalysing Change in Chemistry Education

Società Chimica Italiana
Coordinated by its Didactics Division

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Abstract Book

DRAFT

Welcome

On behalf of the Italian Chemical Society and of its President prof. Vincenzo Barone, it is an honour, a privilege and a pleasure to invite you to Rome in July 2012 on the occasion of the ICCE and ECRICE conference. For the first time, the two major conferences on Chemical Education will join under the same roof, that of Rome, the eternal City: we are really proud for this and we will do our best to ensure full success of the event and a wonderful Italian trip of all the conveners. Chemical Education is constantly undergoing major changes and developments which are also connected to the changing role of Chemistry in Society and the way this science is perceived; as it always more becomes a Science where social, scientific, cultural and didactic aspects interact with each other and with other emerging disciplines such as Museology, Ethics, Communication Science. We hope that the Rome Conference will be remembered in the future for its contribution to the growth of the quality in Chemical Education. We are working hard to assemble a high-level scientific program as well as setting up working, living and leisure conditions suitable to make ICCECRICE 2012 a memorable event.

I am sure that you will like to be part of it.

See you in Rome!

Luigi Campanella
SCI Past President
Conference Chairman

Dear participants

As Chairman of our Conference and as Director of Chemistry Museum of our University I invite you during the period of your staying in Rome for ICCE ECRICE 2012 to visit our Museum. You can find some precious cases of old instruments and some particular pieces of old traditional chemistry. The most important instrumental methods of chemical analysis are represented starting from chromatography and passing to spectroscopy, X-ray, NMR techniques. A collection of old reagents, dyes and glassery is also exposed. The Museum will be open daily waiting for you on all days (from Monday 16th to Friday 20th July) at 9hr-18hr. The Museum is located inside University campus in the Chemistry Department at ground floor.

If some of you is also interested in visiting some labs of our Department please don't hesitate to contact me and I'll do the best to satisfy your request. Our Department of Chemistry is one of the most scientifically complete as any field and branch of Chemistry I can say it is represented.

Thanks and welcome.

Luigi Campanella

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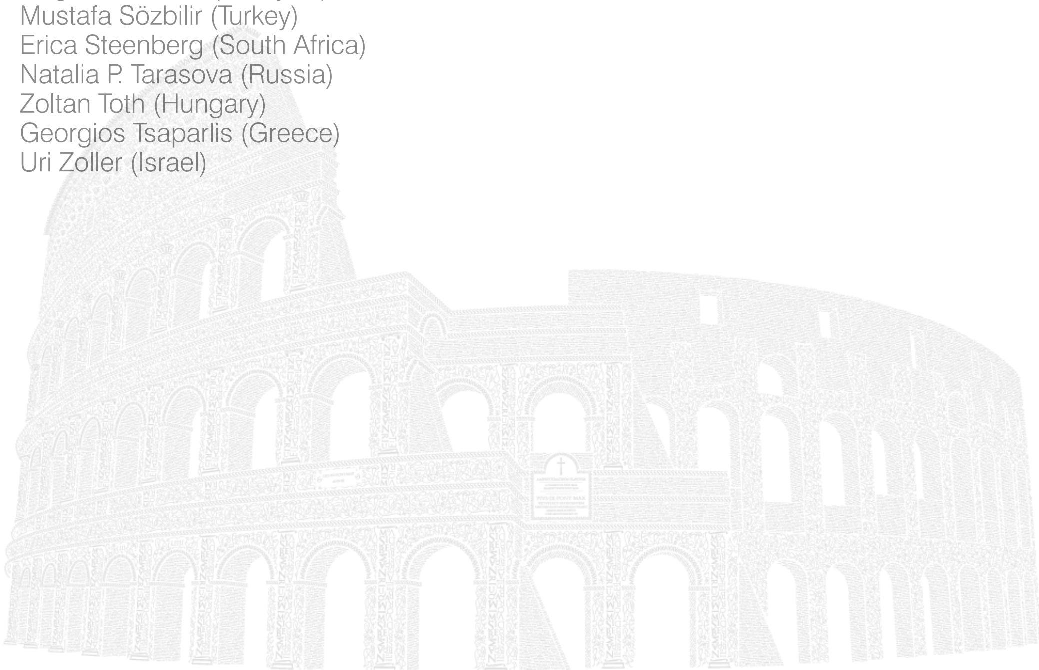

PLENARY AND KEYNOTES

THE ROLE OF SCIENCE IN A FRAGILE WORLD

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As science expands, technology develops and the world becomes more fragile because of bad or incautious use of the most recent technological advances. There is, however, another reason why the world is fragile: we do not realize that the Earth is a spaceship with limited resources that carries 7 billion people. The biggest danger, indeed, comes from too much consumption of natural resource, too much waste generation and too much disparities among the passengers.
Up until now we have taken from Nature any kind of resources to increase our well-being. Only a relatively small part of mankind, however, has made use of them, and it appears that there are insufficient natural resources to bring all people at the level of consumption of affluent countries. Which is the role of scientists in our world today? Some scientists are only interested in their own research and do not care about the situation of the world. Responsible scientists, however, while creating with the greatest moral care new science and technology, should also play an important role as authoritative, informed, and concerned citizens of the planet Earth. As pointed out by Richard R. Ernst, "*When we set out, by our research activity in the laboratory, to incrementally influence the course of history, we are also requested to contemplate the desired long term global development. Who else, if not the scientists, is responsible for setting guidelines for defining progress and for protecting the interests of future generations?*" [1]. Our generation has the crucial duty to achieve a sustainable economic growth with a greater social cohesion.

Until now, mankind has taken from Nature enormous amounts of resources. Science, chiefly chemistry, should now allow mankind to reverse this trend. Starting from seawater and the fundamental components of our atmosphere (nitrogen, oxygen and carbon dioxide), by means of solar energy, we will hopefully "fabricate" not only fuels, electricity and pure water, but also polymers, food and almost everything else we need. With the extraterrestrial input of solar energy, we will pay back Earth with a capital generated from human intelligence. This is the most important scientific and technological challenge of the 21st century [2].

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SCIENCE, LOST IN TRANSLATION?

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Fluency in a language is fundamental to an understanding of any culture and the struggle to develop the language of the Sciences, mathematics and related symbolism, proved to be unnaturally difficult. In fact Science was born around the time of the 16^{th} Century as a consequence of a new philosophical approach which required evidence for the validation of all claims without exception. This way of thinking suddenly uncovered the fact that the common-sense attitudes that are necessary for basic survival are actually quite unreliable when it comes to understanding how the Universe works. So Natural Philosophy, *which is the only philosophical construct we have to determine truth with any degree of reliability*, was born. The Enlightenment was the byproduct of this philosophical breakthrough and Science its Prodigal Son. From the moment of birth this philosophy has engendered conflict with those who claimed authority, and indeed still hold great sway over society, on the basis of unsubstantiated and unsubstantiatable dogma. This conflict continues to this day as mystical and other dogma-based attitudes are intrinsically impervious to rational argument and will, almost certainly, lead to serious consequences for the human race in the future. Science, arguably the most influential factor in shaping the modern world, has been so incredibly successful that most no longer need even common sense (at least in the developed world) to survive. Although there have been negative consequences most people would feel that society has in general benefited greatly from the application of scientific advances *ie* Technology. However this very usefulness has obscured the fact that Science, *aka* Natural Philosophy, is actually a supremely cultural, intellectual and, most importantly, an intrinsically ethical activity, particularly with regard to deciding what is or can be true. As so few people are mathematically literate it is not surprising that there is little real understanding of what Science is or how scientific advances are made. This is a dangerous situation as this illiteracy applies to almost all politicians and administrators who have responsibility for making socio-economic decisions involving scientific and technological matters. Furthermore The Enlightenment, which can only survive in a democratic environment, is under threat as those who arrogate their power and influence through dogma, mystical dogma in particular, are conspiring to drag humanity back into a Second Dark Age.

There is only one hope and this resides in a massive global educational offensive to improve the general level of knowledge and thinking. *Although knowledge cannot guarantee good decisions, common sense suggests that wisdom is an unlikely consequence of ignorance.* Fortunately there has been a major advance in that the birth of the Internet offers the second most important advance in education since the invention of the printing press. I would argue that Wikipedia is an amazing example of what can be achieved. Our GEOSET programme (www.geoset.info see also www.vega.org.uk) is a related project which aims to harness the efforts of educators via the Internet in a synergistic exercise to improve the knowledge and understanding of people wherever they are in the World and in particular help teachers achieve this end.

DO REAL WORK, NOT HOMEWORK

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Traditional academic homework is limited in what it can accomplish. In this presentation, I will outline some principles for more authentic a tasks (real work) that can promote the complex outcomes we want from education. I will provide examples of how we have designed “real work” learning environments as well as how research has allowed us to understand them.

STIMULATING AND REFLECTING OVER THE HISTORY OF CHEMISTRY TO FACILITATE CONCEPTUAL CHANGE

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Most high school and university freshman students have considerable difficulty in understanding chemistry. Furthermore, it is generally ignored that students lack the motivation for studying chemistry. A review of the research literature reveals that history and philosophy of science are particularly helpful in stimulating students' interest and consequently understanding of scientific progress. Traditional chemistry curriculum and textbooks present scientific progress as a 'finished product', devoid of any difficulties, ambiguities or uncertainties. Taking a different approach this presentation provides a glimpse of 'science in the making', that is scientific practice imbued with arguments, controversies, and competition among rival theories and explanations. Teaching about 'science in the making' is a rich source of stimulating students to engage creatively with the chemistry curriculum. Some of the historical episodes that can illustrate how students' can be motivated to study chemistry are: a) Early attempts to classify chemical elements (including D. Mendeleev) were based on Dalton's atomic theory and still most chemistry textbooks give the impression that for almost hundred years (1820-1920) scientists had no idea or never asked the question as to whether there could be an underlying pattern to explain periodicity? b) J.J. Thomson and E. Rutherford had very similar experimental data with respect to the alpha particle experiments and still their interpretations were entirely different, and thus postulated different atomic models; c) R. Millikan and F. Ehrenhaft, performed very similar experiments to determine the elementary electrical charge and still Millikan postulated the existence of a universal charged particle (electron) and Ehrenhaft postulated fractional charges (sub-electrons); d) Postulation of the covalent bond by G.N. Lewis had to compete with the rival hypothesis of transfer of electrons (ionic bonds), and his hypothesis was considered to be 'bizarre' and ignored for many years; e) R. Millikan provided the first experimental evidence for Einstein's photoelectric equation and still rejected the underlying quantum hypothesis, which he considered to be 'reckless'; f) A. Einstein and L. de Broglie suggested wave-particle duality before there was any conclusive experimental evidence. Students need to understand that progress in science is not merely based on the accumulation of experimental data, but rather dependent on the creative imagination of the scientific community, that is understanding science as a human enterprise.

ACTIVE LEARNING: ON SENSIBLE AND LESS SENSIBLE CONCEPTIONS OF 'ACTIVE' AND THEIR INSTRUCTIONAL IMPLICATIONS

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If an educator stated that active learning is important s/he would probably not get any contradiction. However, what does that mean exactly? Actually, there are rather different conceptions of "active learning." Most socio-constructivist approaches have adopted an active responding stance. They regard visible, open learning activities such as solving complex problems, hands-on activities, or argument with peers as necessary for effective learning. This view is, however, challenged by empirical evidence and has theoretical problems. If we assume that learning takes place in the individual learner's mind, then what the mind does, and not overt behavior, is central. Accordingly, the active processing stance—the typical stance of most cognitively-oriented educational psychologists—regards effective learning as knowledge construction resulting from actively processing to-be-learned content. Although active processing might be necessary for knowledge construction, it can become unfocused. In inquiry learning environments, for example, learners may focus on peripheral information, which may delay or even prevent the acquisition of important content. Against this background, I have recently proposed a modification of the active processing stance. The focused processing stance claims that it is crucial that the learners' active processing is related not only to the learning content but to the central concepts and principles to be learned (e.g., chemical laws).

The focused processing stance is of special relevance to science learning because many current approaches plead for "active learning." Many of such active-learning arrangements might not, however, sufficiently support the learning to focus on the central concepts and principles. In this talk I will present instructional procedures and findings from three lines of research that are relevant in helping learners focus on central concepts and principles: (a) Replacing problem-solving demands by worked solutions in the beginning of the learning process in order to reduce unproductive problem-solving attempts; (b) informing the learners of the intended function of a learning environment's "supportive" features in order to optimize their use; (c) prompting by specifically-designed questions in order to focus the learners' attention on the central principles of the learning domain. The findings confirm that it is crucial not only to induce active learner involvement but also to support focused processing in order to optimize learning outcomes.

SOME RESEARCH KEYS TO SUCCESSFUL CHEMISTRY EDUCATION

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By its very nature, chemistry is an exciting subject in that the findings from chemistry have helped mankind to make sense of our world and enabled us to be able to make developments which have enriched the lives of billions. However, chemistry is often seen as difficult, boring and irrelevant by learners. This presentation seeks to pinpoint the key findings from empirical research which can help us to make chemistry increasingly attractive, stimulating and exciting.

We need to be able to see clearly what are the key goals for chemistry education at both school and university levels. We are seeking to release the full potential of learners and enable them understand and apply what they have learned in ways that are meaningful to them and of value to wider society as well as develop key thinking skills which will enrich the learner throughout life.

Chemistry is often not an easy subject to understand simply because it makes considerable demands on cognitive resources. Specifically, the working memory is where we think, understand and solve problems. Its fixed and limited capacity make conceptual chemistry hard to grasp. However, research has shown key ways by which the effects of this critical limitation can be minimised. These will be outlined.

When the working memory cannot cope, learners resort to memorisation. This leads to a rapid deterioration in confidence and generation of negative attitudes. The key factors which enable chemistry to be seen as accessible, attractive and popular are well established. The key task is to interpret these into our own curricula, teaching and assessment practices.

This literature will be summarised and exemplified, giving a set of principles which, if applied, would take chemistry teaching and learning forward into an exciting future.

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COMMUNICATING CHEMISTRY VIA DEMONSTRATIONS

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Science is fundamentally a human endeavor, driven by the same impulses that motivate much of human activity: curiosity about the unknown, the thrill of discovery, delight in creativity, and the benefits derived from understanding. Fundamental, too, is the desire to share the curiosity, thrill, delight, and benefits. This desire to share is perhaps most acutely displayed by science teachers, whose deepest desire is to effectively communicate the beauty of science, both in and out of the classroom. One of the most effective means of communicating this beauty, of stimulating curiosity, and of sharing the thrill of discovery in science is through demonstrations of physical phenomena. Through my experience in presenting demonstrations, I have come to appreciate that there are characteristics common to effective demonstrations, and I shall share during my talk. For example, in planning to use a demonstration, I always begin by analyzing the reasons for presenting it. Whether a demonstration is spectacular or quite ordinary, I undertake to use the chemical system to achieve specific teaching goals. I determine what I am going to say about the demonstration and at what stage I should say it. Prior to the lecture, I practice doing the demonstration. By doing the demonstration in advance, I often see aspects of the chemistry that help me formulate both statements and questions that I will use in class and in other settings.

LEARNING IN AND FROM CHEMISTRY LABORATORIES: RESEARCH AND PRACTICE

Avi Hofstein

Over the years, the science (and chemistry) laboratory was extensively and comprehensively researched and hundreds of research papers and doctoral dissertation were published all over the world (Lazarowitz & Tamir, 1994; Hofstein & Lunetta, 2004; Lunetta, Hofstein & Clough 2007). This embracement of practical work, however, has been contrasted with challenges and serious questions about its effectiveness and benefits (Hodson, 1993; Hofstein & Lunetta, 2004). For many teachers (and very often curriculum developers) practical work means simple recipe-type activities that students follow without the necessary mental cognitive oriented engagement. The aimed-for ideal of open-ended inquiry in chemistry learning in which students have opportunities to plan an experiment, to ask questions, to hypothesise, and to plan an experiment again to verify or reject their hypothesis happens more rarely - and when it does, the learning outcome is much discussed.

This lecture will discuss research on practical work (mainly in the context of chemistry teaching and learning) in order to demonstrate its potentials but also its challenges and problems. A main point to be made is that practical work is not a static issue but something that has evolved gradually over the years, and which is still developing. The development relates to changing aims for science education, to the developments in understanding of science learning, to changing views and understanding of science inquiry, and to more recent developments in educational technologies. To demonstrate this we start with a review of practical work along historic lines, looking back at practical work research over the last 50 years. Following from these the second part of the lecture will elaborate on four different themes which summarize the state of affairs of practical work at the beginning of the 21st century and points towards new possibilities and goals. The four themes are: how is practical work in chemistry used by teachers, the influence of new technologies, "metacognition" as one of the key factors in laboratory learning and the issue of "scientific argumentation" as a promising replacement of "science method.

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WHERE DO WE GO FROM HERE?

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At the conclusion of the first joint ICCE-ECRICE conference, we will reflect on where we are as a global community of research and practice in chemistry education, and where we would like to be. To facilitate our reflection, we will "think like chemists": How can we characterize our "starting materials, educts, and products," what are possible "pathways and mechanisms along the reaction coordinate," what could our "catalysts" be to reduce the "activation energy" for desired developments in a dynamic educational system?

In our talk, we first define "here." What do we know about the students and teachers in our classrooms and laboratories? What have we learned about student pre-conceptions and misconceptions? Are the students in our classrooms actively engaged in their own learning? How well does the content of our present curriculum authentically reflect the domain of chemistry? Is it relevant to the global challenges our planet faces?

We then look at each of these features characterizing where we are now, and ask where we would like to be - perhaps even by the time of the next joint ICCE-ECRICE conference. In moving from 'here' to 'there' it may be helpful to consider ways in which we can take more authentic approaches to the teaching and learning of chemistry. What role can existing and new approaches to research, including systemic approaches, play in helping us to move along the pathway from "here" to "there?"

GLOBALIZATION OF CHEMISTRY EDUCATION

Mei-Hung Chiu

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Committee on Chemistry Education, Chair

Globalization has received a great deal of attention from different disciplines and different countries. However, this was not true for chemistry education until the proclamation of 2011 as the International Year of Chemistry (IYC). The IYC linked people together, from across the globe, in recognition and celebration of chemistry's achievements and contributions. Specific IYC activities provided numerous opportunities for people on different continents to appreciate chemistry locally, nationally, internationally, and globally. In this presentation, I elaborate on what globalization means to chemistry education, and on how new research is changing classroom practice across the globe. I will also highlight the strategies we can develop to keep the momentum from the IYC moving locally and globally. In addition, I discuss the actions that we as chemistry educators can take, and what policy makers can do, to achieve the goal of promoting global citizens' literacy in chemistry. Some possible solutions to these questions include: (1) to disseminate findings from chemistry education research to motivate student learning and promote teacher professional development for informing chemistry education in classroom practice, (2) to continuously develop worldwide experiments and activities to bring people together through these shared experiences and similar goals, (3) to build international standards (or guidelines) for chemistry education that are applicable for developing as well as developed countries in order to empower global citizens' capacity in a scientific context, (4) to enrich the collaborative interaction between chemists and chemistry educators in developing innovative curriculum and useful resources, and (5) to link academia with industry to provide connections between school learning and practical work. Maintaining the focus on the IYC theme, "*Chemistry-Our Life, Our Future*" will help people everywhere to value chemistry as a human enterprise that supports not only our present way of life but also holds promise for improving our collective future. Improving chemistry education to ensure high quality opportunities to engage in learning is at the center of this focus.

CHEMISTRY, LIFE, THE UNIVERSE AND EVERYTHING

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Chemistry plays a central role in scientific understanding, and General Chemistry is the university course where many students begin – and end – their college level chemistry education. It is where many teachers of physical science and chemistry learn most of their relevant chemistry, and as such is the course with the greatest impact on the public perception, knowledge and understanding of chemical principles.

However, the structure of the traditional general chemistry course does not appear to be effective for promoting deep conceptual understanding or an interest and pleasure in learning chemistry. There have been numerous calls for reform of chemistry education: white papers have been issued, committees convened, curricula developed, and tests written, yet few are satisfied with the outcomes and little seems to have changed. Is there hope? We believe so. This presentation will focus on how and why an understanding of basic chemistry concepts is important for everyone, and how we might change our approach to chemistry education to achieve a deeper understanding.

STRUCTURE OF MATTER – DIAGNOSIS OF MISCONCEPTIONS AND CHALLENGE

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Asking advanced high school or college students about their mental models regarding smallest particles in acid, base or salt solutions they very often respond: HCl or H-Cl molecules, NaOH or Na-O-H molecules, NaCl or Na-Cl molecules. They know about the atomic structure and the ionic bonding from their lectures – but unfortunately they are not thinking of existing ions as particles of matter [1]. By empirical researches we learned a lot about these and other misconceptions: relating to the octet rule, the noble gas atomic structure, electron transfer, electron sharing, polar bonds, etc. [2]. In England [3] and Australia [4] these misconceptions are also found.

We created units to prevent students from developing misconceptions. In chemistry classes, an early introduction of a periodic table containing "atoms and ions as basic particles of matter" [2], mental combinations of different ions, the construction of sphere-packing models for visualizing the structure of salt crystals, makes students catch the idea of existing ions and of ionic bonding without using the nucleus-shell model of the atom. Later in the curriculum, the knowledge of atomic structure and redox reactions relating to the ion formation should be added.

The presentation will show some interesting misconceptions and resulting problems in chemical education. But the lecture also will show the idea of the new periodic table, of mentally combining ions to ionic lattices, and building sphere-packing models representing the ionic lattice of sodium chloride crystals. Finally, beaker models [2] of the ions in aqueous solutions of acids, bases and salts should be reflected to help students for a conceptual change.

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ENGAGING AND CHALLENGING FIRST YEARS STUDENTS IN CHEMISTRY

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Student engagement is a key factor for success in 3rd level education. Many studies have shown the links between student engagement and student retention, e.g.[1]. Engagement provides students with valued opportunities for learning and personal development and gives them a sense of connectedness, affiliation and belonging [2]. However, there are two features of student engagement, the first being the amount of time and effort that students put into their studies and other educationally relevant activities. The second is how the institution 'entices' students to participate in activities that lead to the experiences and desired outcomes, through use of its resources, organisation of its curricula, provision of support services and other learning opportunities. It is the latter aspect that will be discussed in this talk.

Within the context of chemistry teaching at 3rd level, we have additional challenges. Many institutions combine introductory chemistry courses for cohorts of students pursuing different science programmes. Therefore the introductory chemistry modules are given to a very heterogeneous grouping in terms of e.g. their discipline interest, previous knowledge in chemistry, level of practical skills in laboratory as well as their general level of preparedness for 3rd level, their motivation for 3rd level, their ICT skills and their degree of learning autonomy.

From the conceptual framework of influences on student learning[3], key influences have been identified and applied in first year chemistry teaching in order to create a positive learning environment. These will be discussed both in terms of a laboratory module and also a multidisciplinary module. The strategy for this development was built on the profile of preparedness of incoming first year students for studying chemistry[4], the need to develop appropriate assessment strategies and to present appropriate learning challenges. Interesting generalisations may be made for creating an environment for engaging and challenging first year students in chemistry studies.

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USING IDEAS FROM RESEARCH TO CHANGE PRACTICE IN THE CHEMISTRY CLASSROOM

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It is well documented that Chemistry is among one of the most difficult and conceptually challenging subjects on the school curriculum. Many factors contribute to the complex nature of this subject and much work has been carried out in attempting to make the content of this subject more accessible for those studying it. The findings and recomendations of the vast array of studies carried out in the area of Chemistry Education are a valuable resource to any teacher of the subject. Unfortunately more often than not results of Chemistry Education research never make it as far as the classroom.

Working within the tight constrains of the Irish Chemistry syllabus the *'ITS Chemistry'* programme was developed. '*ITS Chemistry'* stands for **I**ncreasing **T**hinking **S**kills in Chemistry. **It is a research informed curriculum.** The programme organised ideas, strategies and findings from Chemistry Education research and applied them to the current Leaving Certificate Chemistry curriculum. More specifically this programme integrated techniques which have been proven to increase the cognitive development of the pupil and address the chemical misconceptions they may possess into the Chemistry syllabus. Overall the programme aimed to develop thinking skills, address misconceptions and alleviate difficulties pupils are having with a number of introductory topics on the Chemistry syllabus, hence providing them with a more secure foundation for the further study of Chemistry.

This intervention programme was developed for pupils who had just completed their Junior Certificate (approx. age 16 years) and who had chosen to study Chemistry for their Leaving Certificate examination. Previous investigations (Childs and Sheehan, 2009) have shown that the Mole and calculations involving the Mole are perceived as being difficult. The Particulate Nature of Matter was also identified as an aspect of Chemistry in which pupils possessed a large number of misconceptions. As a result the Mole and the Particulate Nature of Matter were selected as the subject matter for this intervention programme. Participating teachers underwent training at the start of the school term. During training the history of this project and the structure of the intervention programme and how it fits in with the established Leaving Certificate Chemistry syllabus was explained to teachers. These Chemistry teachers and one of the authors (MS) then implemented the ITS Chemistry programme.

Very positive results were recorded by this intervention programme, with gains being made in the area of cognitive development and chemical misconceptions. Such gains can be accredited to the integration of techniques from Chemistry Education research that have been proven to work into the exisiting syllabus and also to the new awareness teachers had for research into the area of teaching and learning in Chemistry. This investigation shows how positive findings from Chemistry Educaiton research can be harnessed and used by second level Chemistry teachers for the good of their pupils.

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LINGUISTIC HETEROGENEITY: CHALLENGE FOR MODERN CHEMISTRY EDUCATION

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Adult multilingualism is viewed as advantageous in the current, global business world and community. However, multilingualism in the school context is perceived as a source of conflicting issues and deficits. Ever since the first PISA (OECD, 2006) and IGLU studies (Bos et al., 2003) were published, student linguistic issues have been getting increased attention in political arena. Furthermore, students with migration backgrounds proved to be more attentive with respect to the language used in Chemistry lessons. However, answers given by these students also tend to be much shorter and less complex, with less usage of specific, scientific terminology. Additionally, German teachers often do not accept the teaching of German as a necessary goal within their own science lessons. In many cases, they attempt to relegate it to an ancillary position, as an issue which should be addressed by other subjects, e.g. in German lessons. This paper discusses a collaborative research and development project carried out by science teachers, German as a Second Language teachers, and science educators. The project was developed under the framework of Participatory Action Research in science education (Eilks & Ralle, 2002). It focuses on the development of teaching modules for early lower secondary science (grade 5, age 10-11) on different topics. The teaching modules consequently implement learning content and language as envisioned in the Content and Language Integrated Learning (CLIL) approach. All of the lessons are structured using cooperative and autonomous learning methods. The accompanying research attempts to answer the following question: to what extent it is possible for pupils to learn science content, scientific terminology and the German language simultaneously as the learners work autonomously in cooperative settings? Data was collected from student feedback questionnaires, cognitive tests, observations and teachers' feedback. The results show that the lesson plan in question can potentially improve students` learning of science subject matter, while bettering the participants' German language skills simultaneously. This paper provides insights into the structural elements of the lesson plan and also reflects upon the potential and impact of the cooperative and autonomous learning method selected for the success of the lesson plan.

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TEACHING CHEMISTRY IN A NON CHEMICAL COLLEGE

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This communication focuses with our teaching experience in a "non-chemically-friendly" environment, with special emphasis on the course of ENVIRONMENTAL IMPACT AND RISK ASSESSMENT at the Faculty of Economics of the "Sapienza" University of Rome.

The differences in the perception of the concept of "environment" between economists and hard scientists is fully debated, especially since it may have a critical impact on the development of a new management class. The energetics of a production process is indeed most often limited to the needs in terms of matter and energy used to realize end products whose commercial value is higher than the starting component of the process, with the risk of neglecting the other two components of the system, that are information and entropy.

The need of strenghtening the importance of a sufficiently solid background on the basic biochemical and physico-chemical principles also in a faculty of economics is discussed. Obviously the teaching strategy has to take into account the different "environmental" context and to be tailored according to the needs and background of the student audience. The experience of the last 10 years has shown that the "encyclopedic approach" (i.e. mainly mnemonic) did not give encouraging results, while a more example-based and case-study approach better allowed to explain the importance of chemical concepts to students not familiar with "traditional" environmental chemistry.

ABSTRACTS

CHANGING PERSPECTIVES: UNDERSTANDING STUDENTS' EPISTEMOLOGICAL DEVELOPMENT IN CHEMISTRY

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Research has documented the importance that epistemology plays in how students approach learning. Students with more mature epistemological views perform better academically on average, tend to be more adept problem-solvers, and are more persistent. Previous work conducted by our group led to the development of the Chemistry Expectations Survey (CHEMX), a valid and reliable survey instrument designed to measure facets of students' epistemological views of learning chemistry. Using CHEMX, we documented how students' views changed as they progressed through the courses required of a typical chemistry degree. We are currently conducting a long-term longitudinal, qualitative study to identify the factors, both curricular and extracurricular, that influence and shape epistemological development in chemistry students. This presentation will highlight results collected from the first two years of this study and discuss future directions for research.

EXPLORING CRITERIA FOR SELECTING PROPER ORIENTATIONS OF 2D AND 3D MOLECULAR REPRESENTATIONS IN CHEMISTRY EDUCATION

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The use of a molecular representation for performing chemistry tasks requires a series of cognitive operations in the spatial domain, such as recognizing the graphic conventions, manipulating spatial information, mentally tracking constrains and doing transformations between 2D and 3D representations. The aim of our research is the determination of more perceivable and suitable orientations of molecular structure representations for implementation in chemistry educational material. The main objective of this research is the investigation of chemistry students' cognitive ability to transform between 2D and 3D molecular representations.

A diagnostic application, consisted of two parts examining participants' ability to transform a given 2D to a 3D configuration (2D→3D part) and vice versa (3D→2D part), was designed, developed and implemented in totally 68 first and fourth year undergraduates, as well as 17 postgraduate students in our Chemistry Department. The examined stimuli in both parts are static 2D and 3D representations of substituted and non substituted tetrahedral structure of methane (CHBrClF and CH_4). The diagnostic instrument records participants' response times and errors in matching images of 2D and 3D representations. The aim and purpose of data analysis was to examine students' transformation ability between 2D and 3D molecular representations as well as to investigate the influences of the orientation of the tetrahedral structure, the amount of embedded spatial information and students' prior experience or familiarity with molecular representations gained from their previous engagement with chemistry domain on such a cognitive task. For each participant a log file was recorded containing the correctness of their selection and the response time (RTs) per item in milliseconds. Finally, an exit survey was conducted regarding participants' attitudes and beliefs toward the difficulty of the test in terms of the cognitive task and the strategies they had used. The results of this research reveal that students are more able to transform 3D molecular models to 2D symbolic representations than to conduct the reverse mental task. Moreover, the vertical or horizontal orientations as well as the increased visual information of the examined molecular configurations favour students' transformation ability.

The latter suggest simple criteria for choosing suitable representations which does not cause extra load on chemistry students' working memory.

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LEARNING FROM TEACHING: GRADUATE TEACHING ASSISTANTS' EXPERIENCE IN THE ACADEMIC CHEMISTRY LABORATORY

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Graduate teaching assistants (GTAs) play a prominent role in chemistry laboratory instruction at large US universities. However, their role in laboratory instruction has too often been overlooked in educational research. Interest in GTAs has been mostly limited to training[1] and to their perceived expectations[2], but less attention has been paid to the potential benefits from teaching.[3] The purpose of this presentation is to report findings from a research program designed to investigate the kind of effects that engagement in instructional environments has on GTAs, particularly on aspects related to their professional and scientific development.

Two general chemistry laboratory programs that represent two very different instructional frameworks were chosen for this study. The first program[4] used a cooperative project-based approach that would be categorized as problem-based.[5] The second program[3] used weekly, verification-type activities and would fall under the expository category.[5] The purpose of exploring the teaching experience as lived by the graduate assistants led us to utilize a phenomenological methodology of inquiry.[6] GTA end of the semester interviews were collected until saturation was reached and served as the primary data source. Findings suggest that appropriate teaching experiences may contribute towards better preparing graduate students for their journey in becoming scientists, specifically in relation to their epistemological and metacognitive development.[4] Furthermore, the findings shed light on a potential relationship between GTAs' development of a self-image and the enacted curriculum.

A follow up multi-case[7] study was conducted to further explore the impact of GTAs' self-image on laboratory instruction. Findings suggest that GTAs' construction of their self-image is shaped through the interaction of several factors: prior experiences, training, beliefs about the nature of knowledge and laboratory work, and involvement in the laboratory setting. We believe findings from these studies may assist laboratory instructors and coordinators in reconsidering, when applicable, GTA training and support in a new and different light.

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USING DISCOURSE TO ENHANCE STUDENT UNDERSTANDING OF PHYSICAL CHEMISTRY

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Discourse in the science classroom has been highlighted as an important way that students develop an understanding of scientific concepts including equations and the meanings they are intended to represent (1). Methods for analyzing student interactions and construction of knowledge and the increased adoption of active learning strategies to teach physical chemistry provide a unique opportunity to investigate how students develop understandings of mathematical equations and fundamental concepts in physical chemistry, as well as the roles of curricular materials and instructor actions on student reasoning and conceptual growth.

In this work, Toulmin analysis has been used to code argumentations (2) that occurred during a five-week portion of a physical chemistry class focusing on thermodynamics. Across the data, a key feature of argumentations in both whole class and small group discussions is the use of multiple types of evidence to make claims about chemistry, including evidence related to particulate, symbolic, and experimental evidence. Analysis of the transcripts provides evidence of the emergence of classroom social norms to provide reasoning for explanations and for sociochemical norms that a component of reasoning about new topics include a particulate level explanation. The insights gained from this work have implications for how instructors can help scaffold student reasoning not only in physical chemistry classrooms, but in STEM classrooms at many institutions.

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QUESTION-ASKING ON UNFAMILIAR CHEMICAL PHENOMENA: DIFFERENCES BETWEEN STUDENTS, PRESERVICE TEACHERS AND EXPERTS

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Introduction: Questioning is one of the thinking processing skills for developing critical thinking, creative thinking and problem solving. Nevertheless, students ask very few questions in usual classroom situations. In this study we examined how experts, pre-service teachers and students of different educational levels facing to unfamiliar chemical phenomena. The aims were: 1) To stimulate and to analyze the questions asked by students, pre-service teachers and experts when they try to understand chemical phenomena; 2) To study the influence of the level of knowledge on the questions asked.

Keywords: questioning skills, chemistry learning, and chemistry teacher education.

Method: Previously, we selected two chemical phenomena that generate perplexity and we stimulated subjects to ask questions by means of: a) Individual observation of chemical phenomena ("the blue bottle" and "cloudiness"); b) Subjects' privacy in question asking; c) Rewarding the effort asking questions; d) Setting one goal for the task: understanding for explaining.

Under the assumption of ISQ (Information Seeking Questions) came from failed inferences, we adapted the taxonomy of inferences proposed by Trabasso and Magliano (1996) to analyze the questions asked by subjects:

- T1: Questions addressed to know the entities (objects or events), their properties or characteristics. The usual expressions are "*What, When, Where*…?"
- T2: Addressed to justify objects or events (causality). They are usually expressed as "*Why*" questions.
- T3: Addressed to anticipate future events, consequences or what would happen if things were different.

Subjects: 34 high-school students, 31 secondary students, 19 secondary pre-service teachers, and 10 chemical experts (academics and researches in analytical chemistry).

Results and Discussion: The procedure and didactic strategies used generated a relevant and significant amount of questions. The averages per student were 7, 42 questions in 12 minutes.

The most pronounced similitude between the questions asked by students, pre-service teachers and experts is their special interest in identifying the types of substances involved in the chemical phenomena. What differs are the conditions under which specific strategies and representations are manifested in their questions. Experts ask high-level questions that involve a variety of inferences and representations base on the underlying principles of the domain.

SCHOOL SCIENCE PROJECTS FOR THE CONTINUOUS CHEMICAL EDUCATION IN A SYSTEM

“SECONDARY SCHOOL – UNIVERSITY”

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Implementing school science projects in chemistry offers a challenge for mutually profitable cooperation between secondary school and university. Recently the study in developing school science projects with the use of modern techniques of chemical research at the university laboratories has been carried out by the educators of the Department of Chemistry of the Moscow Pedagogical State University and a number of Moscow secondary schools. The Moscow Pedagogical State University (MPSU) is one of the oldest and the most famous in Russia higher educational establishments. In the Department of Chemistry you will find a great deal of activity in both teaching and chemical research.

Twenty projects, e.g. “Measuring heavy metal concentrations in edible mushrooms”, “Chemistry of Champaign”, «Antacids: chemical aspects of medication”, “Biologically Active Additives: are they really good for your health?”, have been designed and carried out by the students. Secondary school students are introduced to the basics of scientific research and analytical procedures of titration, gravimetry, photometry, thin layer chromatography, inversion voltamperometry, etc. They get an initial experience in planning scientific research, carring out informational search on the problem, discussing and presenting the results of their study by means of ICT. Special attention is paid to the basics of scientific writing both in Russian and in English. Their work is supervised by the teachers of chemistry, the university staff and under-graduates of the Department of Chemistry.

Secondary school-university cooperation not only contributes to introducing the secondary school students to the scientific research but also prepares them for the further education at the university granting the possibility to master the habits of the higher educational forms of instruction and increasing the level of the would-be students adaptation. Secondary school-university cooperation in implementing school science projects proved to be effective for developing problem-solving, informational and communicative competencies in the secondary school students and promoting their vocational disclosure.

UNDERGRADUATE STUDENTS' CONCEPTIONS OF ENERGY LEVEL, ORBIT AND ORBITAL

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Quantum theory is one of the successful theories in the history of science. With this theory, many new concepts were introduced. Because of the abstractness and counter-intuitiveness of the nature of the concepts, many students have difficulty in make sense of the concepts. In this study, we examined how undergraduate students understand, relate and discriminate "energy level", "orbit" and "orbital" concepts. Purposively selected 18 undergraduate students in modern physics course participated in the study. By asking some conceptual questions, we requested students discuss these concepts in Bohr atom and quantum atom contexts in the interviews. Students were allowed to think aloud during the interviews and draw or write their statements when they need. Interviews were video recorded and transcribed. The analyses of the verbal data and the artifacts created in the interviews revealed that students use these concepts unconscious and interchangeable with each other. Students' flaws in their explanations indicate mechanistic explanations in quantum atom. In order to get rid of students' conceptual difficulties, the results of this study might enlighten the key points in teaching of these concepts.

STUDENTS' DIFFICULTIES WITH CHEMICAL REACTION TYPES

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Experience and research indicate that student have problems with the identification of chemical reaction types in inorganic Chemistry. The aim of this study was to investigate why students struggle with chemical reaction types. Five hundred first year general chemistry students, 20 fourth year B.Ed. students (final year of teachers training) and 50 in-service teachers doing a fourth year up-grading course (ACE Advanced Certificate in Education) in Physical Science participated in the research study. The results of the current research indicated that students were confused and lacked the ability to correctly apply theory to given problems. Students had insufficient theoretical knowledge, and could not make the link between theory, practical work and problem solving. Moreover, students do not retain enough theoretical knowledge to be able to apply the knowledge successfully. Despite practical work on all reaction types, misconceptions still appeared and no noticeable improvement in theoretical and conceptual knowledge were found. Specific problems included the inability to complete chemical reactions or alternatively, if given the complete reaction equation they could not recognize the reaction as a specific chemical reaction type. In particular, misconceptions in redox reactions, acid-base reactions and other chemical reaction types were identified. This subsequently led to the following questions: What is the origin of the confusion or poorly formed conceptual knowledge that the students have? What is the influence of the explanations of the concepts in textbooks – both first year general chemistry and school textbooks? What role does the progression or the development of the concept of chemistry reaction types from school to university play? What interventions can be implemented to specifically improve the conceptual knowledge of students of chemical reaction types in order to improve recognition of chemistry reactions and the ability to correctly write down reaction equations?

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SCIENCE TEACHING IN THE PRIMARY SCHOOL A COMPARISON BETWEEN “GOOD PRACTICES” CARRIED OUT IN ITALY AND IN FRANCE

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“La Main à la Pate” (Finger in the pie) is a wide experimental project which started in France in 1996 aimed at revolutionizing Science teaching in the primary school: it has deeply influenced the national programs for the primary school that the French Education Ministry proposed in 2002 and recently in 2008. It is a sort of “pedagogical adventure”, which poses pupils in a central position and proposes direct experiments, a strict bonding between science and language, a particular attention to the development of pupils’ imagination and creativity, as well as their logical reasoning and utmost attitude.

These are the same basic principles that inspired the Italian project “ISS - Insegnare Scienze Sperimentali” (Teaching Experimental Science): this project was proposed by the Italian Ministry of Research, University and Education (MIUR) in 2005, in collaboration with Science Teachers Associations (DD-SCI, AIF, ANISN) and some Italian Scientific Museums (Milano and Napoli): now in the Italian Ministry indications for the Curriculum (2007) and in the practice of many teachers we can find some important reminds to the “philosophy” of the ISS project. The target is represented by “competence goals”, gradually distributed along the different school periods: (i) *context of sense*; (ii) *vertical approach*; (iii) *cross-curricular approaches.*

It is worth noting that world-widely these projects are not the only examples of good practices in Science teaching: in fact, according to the PISA (Program for International Student Assessment) survey [1], school performances deteriorated in a large number of Member States. In order to slow down /and possibly to stop) this negative trend, some actions have been taken, among which the so-called Rocard’s report [2], the “Hands on” project [3], aimed at networking science centres and museums to develop programs for primary schools and the publication of the book “Taking Science to School - Learning and Teaching Science in Grades K-8“ [5].

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DEVELOPING A NATIONAL SENIOR CHEMISTRY CURRICULUM

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The development of a new Senior Secondary Chemistry Curriculum in Australia is being developed as part of a new Australian Curriculum. Prior to this year, each state and territory in Australia has been responsible for their own curriculum, with little agreement across the country as to what is learning of worth. Under the current program, a new Australian Curriculum will be phased in from 2012, where each state and territory will interpret the Australian Curriculum to their particular context. In addition the Australian Curriculum has developed achievement standards indicating what learning outcomes are expected from students undertaking these courses of study. How these achievement standards are assessed is again left to be states and territories to determine.

This paper will outline the process undertaken in developing the new Australian Senior Secondary Chemistry Curriculum, paying particular attention to the structure of this curriculum, its representation of the different types of chemistry knowledge and the development of the associated achievement standards.

The Australian Chemistry Curriculum represents some shifts in emphasis from past curriculum, with chemistry knowledge embedded under the strands of Science Understanding, Science as a Human Endeavour and Science Inquiry Skills. For many teachers, this shift in emphasis represents some significant challenges in how they view chemistry “knowledge” as it is no longer confined to chemistry “facts”. Defining knowledge of worth in the strand of Science as a Human Endeavour has provided the most challenge as its focus on the development of science as a unique way of knowing and doing and the role of Chemistry in contemporary decision making and problem solving has not been an knowledge area that many chemistry teachers have experienced for themselves.

Another challenge provided in the development of this curriculum has been in the linking together of all three strands in ways that present a coherent “story” around Chemistry as course of study for students.

This paper will provide data in the form of mapping the shifts in the emphasis in the development of this curriculum, as well as data that details the feedback received from the numerous stakeholders involved in this development process. In this sense the data provides some unique insights into the development of what has been mandated as a contemporary Chemistry curriculum. Contemporary in this instance has been defined as a modern, forward thinking curriculum that accounts for how each discipline (in this case Chemistry) is evolving in it structure and thinking.

The paper will conclude by providing some insights into how a modern Chemistry curriculum can be structured and assessed, accounting for the many influences that mediate such development such as the political environment, the social environment, the cultural environment and the educational environment.

PIANO LAUREE SCIENTIFICHE: A MODEL SYSTEM FOR THE CONNECTION BETWEEN SCHOOL AND UNIVERSITY AND THE DEVELOPMENT OF THE SCIENTIFIC CULTURE

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The drop in scientific vocations recorded in our country since the early 90s led to a deep analysis of the causes that had produced this phenomenon and led to take actions to invert this trend. The Piano Lauree Scientifiche (PLS) is one of the main actions taken at national level to increase enrollments in the degree courses in "hard science" (Chemistry, Physics, Mathematics and Statistics and Materials Science) and to promote the development of scientific culture in our country. This project is based on the collaboration between universities, schools and enterprise associations.

Since 2005, PLS is carrying out a coordinated effort among universities, schools, and enterprises for the guidance of the high school students and for training and professional development of teachers, through various actions that actively involve students and teachers.[1]

This goal is realized by offering students the opportunity: to perform experimental activities in the laboratories of universities, schools and industries; to know the world of universities and research; to get news on the employment opportunities that the degree gives access.[2]

The PLS is widespread throughout the national country through local projects from each of the 32 universities where there is a degree course in Chemistry. The projects are coordinated both at national and regional level: the national coordination has the task to verify the consistency of the activities with the guidelines[2] and to monitor the local projects, using a database specifically designed for the ongoing monitoring and ex post evaluation.

The widespread and structured distribution throughout the national country is a feature that makes PLS a "system" that can potentially play a fundamental role in the implementation and coordination of efforts for the promotion of scientific culture in our country. Furthermore, modalities proposed and implemented in the PLS for the connection between high school and university are an experienced model that can be extended also to other non-scientific disciplines.

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FOLLOWING NEW PATHS BY STUDENT LABS IN TEACHING CHEMISTRY TO CHILDREN WITH SPECIAL NEEDS

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In Germany, extra-curricular student labs increase student interest in a subject area by providing independent and hands-on experiments and is an important innovation in education. The student lab at the university Erlangen-Nuremberg is called NESSI-Lab and focuses on chemistry. NESSI-Lab offers school classes from first to sixth grade, a one day experience in chemistry, with age-appropriate experiments about fire, water, air, and earth. The feedback received from participating students and teachers was very good and resulted in an extension to another target group: children with hearing loss and learning disabilities.

The frequently modified cognitive, linguistic, motorical and social development of hearing-impaired children and children with learning disabilities require adjusting existing experiments, its instructions, and NESSI-Lab schedule. A pilot study was conducted to adopt changes to the Lab to accommodate the restraints mentioned above. The study included a survey of special education teachers about experiments in special education schools. The results of the survey illustrate that linguistic simplification, visualization for instruction, and explaining the experiments using models and breaks, are necessary for hearing impaired students. The measures presented above enable the special needs students to conduct experiments independently and to experience and understand chemical phenomena and their context. The understanding and learning gains have been examined by interviews with 25 hearing impaired children between ages 8 to 10 years.

The results of the survey of special education teachers, the adapted concept of NESSI-Lab, and the results of the interviews are presented in the talk.

THE AUSTRALIAN CHEMISTRY DISCIPLINE NETWORK: A FORUM FOR SHARING

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Changes to student cohorts in the past decades mean that while the important facts of chemistry are not changed, it is nonetheless vital for chemistry teachers to adopt new teaching strategies to assist student learning.[1] Barriers to the adoption of methods that are proven to be more effective include the perception of time and effort required, as well as a very conservative culture within the discipline of chemistry. Our discipline has a very strong identity in research, but a sense of community is lacking within the teaching domain for many academics.

In late 2011, the Australian Learning and Teaching Council funded the establishment of the Chemistry Discipline Network, and by early 2012 it had over 80 members, representing all Australian universities. The aim of the Network is to strengthen the learning and teaching of chemistry at Australian universities by forming a community of practice to exchange experiences, share resources and implement best practice. The guiding principle of the Network is open communication and we have already observed benefits from this.

The Network aims to overcome barriers to the adoption of improved teaching methods by using strategies explored by others[2] and through the open sharing of teaching techniques and resources.

This presentation will detail the current efforts of the Network in three areas:

- a comparative mapping exercise of all current tertiary chemistry at several universities, including what is taught and how it is assessed;
- developing ways to assess students based on the chemistry Threshold Learning Outcomes (http://www.altc.edu.au/system/files/LTAS-Chemistry-TLOs-2-mar-2011-final.pdf);
- a website (chemnet.edu.au) for sharing learning objects and for discussion of any topic of interest to tertiary chemistry educators.

Chemistry
DISCIPLINE NETWORK
chemnet.edu.au

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STUDENTS COLLABORATION SKILLS IN THE TEACHING-LEARNING PROCESS OF CHEMISTRY IN ELEMENTARY SCHOOLS OF LATVIA

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Teaching-learning process in elementary school pays particular attention to student scientific inquiry by cooperating, working in pairs or groups [1], thus acquiring cooperation skills which are the element of social competence, a basic competence each person is to develop during one's lifetime [2]. In order to develop student cooperation skills, teacher must possess appropriate competence. It is, therefore, important to establish how successful teachers are at organizing student cooperation.

The project "Science and Mathematics" developed and during 2010-2011 in 26 schools approbated 24 inquiry laboratory works, performed by the students of grades 8 and 9 in pairs or groups [3]. Student cooperation skills and teacher competences were evaluated by analyzing 30 records from observed lessons and 599 student and 26 teacher questionnaires.

85% of students indicated that they had had good cooperation during performance of inquiry laboratory works and such learning is easier and more interesting. Also 85% of teachers indicate that students have skilfully cooperated when planning and performing laboratory works. Moreover, 92% of teachers evaluated their competence to organize various student cooperation models as good or very good. However, analysis of the lesson observations proves that in only approx. 70% of the cases teachers have successfully selected the student cooperation model and in only 60% of the cases have followed the methodical aspects of the model.

The study shows that student cooperation during inquiry laboratory works is successful but there is nonconformity between the evaluation by teachers and experts. To eliminate the aforesaid nonconformity, it is advised to organize school-based professional development or learning team, which in long-term will help teachers to particularize and reflect upon a particular situation

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PIANO LAUREE SCIENTIFICHE (PLS) - TEACHERS AND STUDENTS TOGETHER IN THE LAB: THE SARDINIAN EXPERIENCE

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The Italian Ministry of Education, University and Research promoted and supported the project proposed by the Department of Chemistry of the University of Cagliari in the framework of Piano Lauree Scientifiche – Scientific degrees project since 2005. The project aimed at establishing a cooperation among Schools, University and Industries for increasing the interest and enrolments in scientific disciplines and for maintaining and improving the high quality standards of science teaching at high schools and technical schools[1,2]. Teachers of Sardinian high schools together with researchers of the University of Cagliari envisioned laboratory experiments designed so that the students learn chemistry through a so-called working knowledge. Teachers participated in the first phases of the project by designing and executing the experiments together with the researchers on topics that represent the state-of-the-art in science: such as adhesion, surface functionalization, production of CO_2 and its reduction, synthesis and characterization of drugs and polymers[3]. Furthermore, they provided an adequate support to the preparation of the students during their lessons. Industries collaborated so far to a minor extent. The results of this project are clearly positive: the students were enthusiastic of the activities proposed. A great interest was chiefly raised among those students who were deeply involved in the experimental work at the university (more than 400 students per year). They appreciated the opportunity of understanding and exploring chemistry by working in the laboratory together with their teachers. Examples of the activities will be presented and the results of the evaluation by the teachers will be discussed.

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Acknowledgments: The authors wish to express their gratitude to the steering committee of Piano Lauree Scientifiche and to the Rector of Università di Cagliari for the financial support of the project. All teachers of Sardinian high-schools, Dr. E. Tocco and dr. S. Cuccu of Ufficio Regionale della Sardegna together with Confindustria Sardegna are acknowledged for the helpful and interesting discussions.

HISTORY AND PHILOSOPHY OF CHEMISTRY IN THE TEACHING OF FUNDAMENTAL CONCEPTS

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History and philosophy of science can be very useful didactic tools for the teaching and learning of several topics of the different sciences taught in basic and secondary schools[1]. The justification of fundamental concepts which are in the basis of the knowledge in those areas requires a philosophical and historical approach, which although proposed in many programs, is almost always ignored in practice, due to the lack of training of most teachers in those matters.

Actually, in what Chemistry is concerned, the historical evolution of some fundamental concepts complemented with a philosophical reflection on the process of the construction of this science[2] are extremely important to facilitate students' understanding of our modern way of viewing these fundamental chemistry concepts[3]. History and philosophy of science also allow clarifying the meaning of the duality theory-experimentation that accompanied the development of chemistry[4] and also the establishment of the present complex chemical nomenclature[5].

In this symposium we intend to get an overview of different approaches for the teaching-learning of some chemistry concepts usually considered difficult by students[6],[7] as well as teaching strategies and teaching materials[8], useful to overcome these difficulties.

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MODELS FROM HISTORY TO THE CLASSROOM: AN HISTORIC-EPISTEMOLOGICAL APPROACH TO CHEMISTRY TEACHING

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In school textbooks, the existence of atoms as the "fundamental components" of matter is usually proposed as an implicit evidence. Far from being presented as a main epistemological obstacle, the discontinuous nature of matter is taken for granted and the atomic hypothesis is reduced to a mere conceptual instrument that provides an interpretation - at the microscopic level - of Proust's empirical law of the definite proportions. Similarly, in the teaching praxis, the idea of a hierarchic organization of matter is implicit: the fact that substances are made by molecules that, in turn, are made by atoms is often given as a self-evidence, although the hierarchical character of such structure and its implications are never discussed explicitely[1].

We know from science history and epistemology that admitting the idea of a particle structure of matter and accepting the atomic-molecular model as the key for interpreting the phenomena involved with chemical transformations of substances implied to overcome several conceptual obstacles. In fact, still in 1909 J.Perrin wrote[2]: "*Je crois impossible qu'un esprit dégagé de toute prevention puisse reflechir à l'extrème diversité des phénomènes qui convergent ainsi vers le meme résultat, sans en éprouver une impression très forte et je pense qu'il sera desormais difficile de défendre par des arguments raisonnables una attitude hostile aux hypothèses moleculaires*". A teaching approach grounded on problem-based learning allows to avoid misleading epistemological simplifications and to show the plausibility of the existence of molecules and atoms starting from the idea of chemical transformation. This can be done by a modelisation activity that may be carried out by students that are already aware of the particle model, as they have built it up on their own in the attempt to provide answers to problems related with the physical transformation of matter.

This proposal is based on epistemological choices and learning hypotheses that leads the elaboration of the content and sequence for teaching. The basic assumptions are: (1) In order to make interpretations and predictions of facts, students have to model the world by theories and models of chemistry. (2) A major difficulty in learning chemistry is to be able to establish relations between the description/interpretation of a system in terms of objects and events and the description/ interpretation of the same system in term of the chemical models. (3) With respect to the teaching sequence, we make the choice of presenting a sequence of refined models of matter, each of which is internally complete and coherent[3].

We will show how students involved in proper modelisation activities are able to connect the microscopic level of atoms and molecules with the macroscopic level of substances. In this way, they are led to construct meaning and knowledge of the concepts of molecule and atom. A fundamental aspect of such approach consists in presenting chemistry as a process that generates knowledge instead of a mere product: this offers the students the opportunity to attach meaning to the concepts they deal with.

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LEARNING TO TEACH NATURE OF SCIENCE - THE IMPACT OF AN EXPLICIT APPROACH

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"Although almost everyone agrees that we ought to teach students about the nature of science, there is considerable disagreement on what version ought to be taught" [1]. In the meantime several implicit and explicit approaches have been tested and it seems as if the explicit approach is the most promising [2]. But research has also revealed that even if the students gain a certain understanding of NOS, this does not automatically enable them to teach it. Thus understanding NOS is a necessary, but not sufficient condition for explicit nature of science instruction [3]. One explanation of this result is given by studies of Akerson [4] and Khishfe [5]. Focusing on the question HOW students' views of NOS changed and why some of them reverted back to their earlier views Bell and Khishfe used the Perry scheme of cognitive development [6]. According to these results the missing link between a temporary and a sustainable changed view of NOS are metacognitive strategies or contextualization [4]. Contextualization implies that NOS is integrated within specific science content, e.g. development of modern chemical conceptions, socioscientific issues or science process skills [7].

Following these suggestions and referring to results of our own former studies with implicit and explicit approaches presented at ECRICE 2010 [8] a contextualized explicit instruction was used in a preservice chemistry teacher course which ran 14 weeks. Within this course the initial explicit instruction in epistemology of science was contextualized by the development of modern chemical concepts as well as socioscientific issues. The contexts also tried to address the problem that students tend to teach NOS additionally instead of making it an integral part of the curricula. Data were collected by an open-ended questionnaire in conjunction with semi-structured individual interviews before, during and after the course, in order to generate in-depth-profiles and their development.

Results and implications for developing a sustainable understanding of NOS that enables to put it into practice will be discussed.

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THE DIAMONDS OF LAVOISIER IN THE TEACHING OF THE CONCEPT OF COMBUSTION IN LOW-SECONDARY EDUCATION

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Several researchers have reflected on the relevance of the use of the history of science in science education being its importance well recognized. One of the valued aspects is their own use as a way of presenting science as a human activity with strong cultural and social meaning, allowing a deeper understanding of the nature of science and scientific knowledge (concepts) and of the work of scientists and scientific communities[1]. Also the study of scientific ideas in their context of discovery helps develop students' conceptual understanding.

Various answers have been given when questioned why the history of science should be an important part of science education. Two of the aspects we want to highlight here and which are goals of education in chemistry are: To promote better and more complete understanding of scientific concepts giving an account of their construction and development[3]; to increase the interest and motivation in learning science[4].

With this study we have as the central objective to show that the original sources of the history of science are a valuable resource for achieving such goals in chemistry teaching.

The Lavoisier' *Elementary Treaty of Chemistry* is a work which, by its emphasis on the construction of the theory of the New Chemistry, has been translated into many languages, establishing itself as a precious educational resource. It is known that Lavoisier was a man with a multidisciplinary vision and formation but also very rich and powerful and that a great amount of his fortune was devoted to the development of chemistry. Using excerpts from his work[5], we present a strategy to the low secondary education for the teaching of the combustion. Beyond the texts and the experimental situations which are possible to perform in class, the strategy includes as a motivator, reading the text of Lavoisier on the combustion of the diamond.

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INCORPORATING HISTORY OF TECHNOLOGY INTO THE CHEMISTRY CURRICULUM: TEACHER VIEWS

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Several studies in education about history of science (Holton & Rutherford, 1970; Klopfer & Cooley, 1961; Matthews, 1994; Niaz, 2008) emphasize the importance of incorporating history of science in science teaching. History of Technology is a sub-level in Seker's (2011) facilitator model of using history of science in science teaching. At this sub-level the goal is to increase student awareness of technological outcomes of scientific discoveries (Seker, 2011). One of the major objectives of high school chemistry curricula in Turkey is to introduce the relationship between chemistry and technology. According to related Content Objectives and Chemistry-Technology-Society-Environment Objectives the students should be aware of the technological outcomes of chemical research (MEB, 2011). Throughout the purpose of an on-going national project in Turkey, educative curriculum materials (Cohen & Ball, 1999; Seker & Guney, 2011) for 9, 10, and 11th grades that included history of science and history of technology content were developed. Ten chemistry teachers employed in different state high schools reflected on the usability of these materials in chemistry lessons. Telephone interviews were conducted and recorded digitally. All recordings were transcribed verbatim. Then, qualitative data analysis methods, open coding and focused coding were employed to create meaningful categories to reveal teachers' perspectives. During the interviews the participant teachers were asked to talk about issues such as their purpose of using the historical stories in the materials, how they used them in their teaching, and their suggestions for further development. Analysis of interviews with teachers revealed that the content related to the history of technology in the materials was effective in attracting students' attention to the lesson. The results also suggest that history of technology content might create awareness on technological outcomes of chemistry research and might answer a possible question in students' minds such as "Why are we learning this?" In several cases teachers felt reluctant to use the materials due to limited lesson hours. Some of the teachers did not use the materials stating that the language was heavy and the stories were long. Despite some negative cases, in most instances teachers suggested that history of technology content in chemistry lessons may help to achieve curriculum goals.

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ANALYSING THE ROLE OF BIOGRAPHIES IN CHEMISTRY EDUCATION: WHAT THEY CAN CONTRIBUTE TO UNDERSTANDING HOW SCIENTISTS AND SCIENCE WORKS

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In this work we present several considerations concerning the elements that biographies could contribute to chemistry education. We analysed two particular cases: biographies from three high school chemistry textbooks and an audiovisual in the form of a fictional documentary about the life of Marie Curie.

The analysis was carried out following a methodology designed to analyse textbooks[1] in which we visualise science as a network where we identify elements that allow us to track how science circulates; we have used previously these elements in analysing audiovisual materials for classroom[2].

Our results show that despite the fact that biographies have elements which justify the criticism they have received in science education[3,4,5] they can improve the contextualisation and localisation of scientific activity by making new connections between those actors that are not generally part of schools' accounts of science: scientists, institutions, and places amongst others.

This fact was further substantiated after analysing the documentary.

We propose that the inclusion of biographies has a vast potential for transmitting a more realistic image of scientific activity—but only if the biographies are specifically designed for teaching and are understood to be narrowly related to the popularisation of science, science education, and the historiography of science. Moreover, biographies can lend more weight to the role of scientists as narrative axes, where then the school discourse can recover the person, that is, the scientist as a subject and individual. Within a setting where school science is primarily centred on concepts this process can strengthen the affective links between students and teachers.

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TRACKING DOWN THE LOST ELEMENTS: AN ANTHOLOGY OF SPURIOUS AND ERRONEOUS DISCOVERIES

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At last count, there are historically many more elements that never made it into the Periodic Table than those that did. The concept of "element" evolved over the centuries, eventually allowing chemists to distinguish simple bodies from compounds on a theoretical basis. Eventually, launched by Bunsen and Kirchhoff's work[1], identifying new elements by spectroscopy was all the rage, and it was easy to "discover" a new element because new lines, or a new combination of lines, appeared everywhere in the spectrum (and gave particularly novel "patterns" in mixtures of already known elements). Three major developments gave rise, in their turn, to a resolution of the false discoveries that dogged the footsteps of chemists for decades.

The first discovery was periodicity. Mendeleev's organizing and predictive tool allowed chemists for the first time to realize that elements could be placed in "boxes," and that there were only a certain number of them that could go around. However, when it came to the rare earths in the 6th period, since there was no precedent, people tried to crowd in more than the fourteen elements that would eventually take their places in the table, thus giving rise to a rash of new false discoveries. The second organizational principle, that of atomic number, was not given definitive form until the second decade of the 20th century, and once again, a limitation on the number of elements based upon the number of nuclear protons, was fixed in place. One more discovery, that of isotopes, was finally able to make sense of such discoveries as an element with atomic mass of three that did not seem to fit anywhere – until it was realized that such an atom could be a heavy isotope of hydrogen or a lighter isotope of helium, and not a new element at all. The concept of isotopes also helped resolve the puzzle over new elements in the area of radioactive decay products.

The book with the above title, newly translated into English from the Italian[2] and completely updated, is an enormous compendium of these false discoveries beginning with the stories of the proto-elements, and their concomitant errors, in 1789, and taking us up to the present time via a series of bizarre elements and elements discovered by recourse to the occult. It is a treasure-chest of false starts and erroneous conclusions drawn by the famous and not so famous, by Nobel laureates and highly respected research scientists, sometimes blinded by their own arrogance, and sometimes by the tantalizing allure of glory and fame. Each of the six sections is a gold mine of detail and primary sources that in themselves will enable students and teachers alike to learn first-hand the tangled road to truth through a morass of error.

The volume is scheduled for publication in late 2013.

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USING HISTORY IN TEACHING CHEMISTRY: HISTORY ON POWERPOINT

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The use of history in teaching chemistry provides the students with a view of the process of science that leads from initial observations to our modern models and concepts. Very little historical background is presented in most chemistry textbooks. It is this author's belief that an understanding of chemistry can be achieved by a skillful presentation of topics set in their historical, social, political, and philosophical background. To supplement that, this author has incorporated historical information into PowerPoint presentations used in classes. This presentation will show a number of PowerPoint slides that can be accessed from the author's website for inclusion into your own PowerPoint presentations.

Topic: Communicating chemistry. History and Philosophy of Chemistry in Teaching Fundamental Concepts.

A NANOEDUCATİON MODEL FOR PRE-SERVİCE TEACHERS: FROM NANOLİTERACY TO ACTİON

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As the research in nanoscience and nanotechnology have been increasing, there has been growing resources for K-12 audiences that address nanoscale science, yet teachers, need to be trained to use these resources (Murday, 2009). Similarly, pre-service teachers should be trained since they will be in class very soon. The purpose of this research was to investigate what the pre-service teachers initially know and feel about nanoscience and how these evolve as they get involve with a series of nanoscience workshops given to students, peers and in-service teachers.

The study has been designed in a qualitative research design which allows more in-depth investigation and understanding of the situation. Triangulation of the data was obtained by open-ended questionnaires, one-on-one interviews, and participant observations. The participants of the study were 14 pre-service teachers of chemistry (N=7), physics (N=2), and mathematics (N=5) in their junior and senior years. They voluntarily took part in 'Nanoscience workshops' and had various roles; as being a group mentor who guided small group discussions while the workshop participants were working on specificic tasks, or being as asisstant mentor who helped the mentors during the group activities; or as support staff who provided technical or material support during the workshops. Totally nine workshops were held. Each pre-service teacher was interviewed before taking part in the workshops, and after participating each workshop.

As a result of the analysis of interviews and observations, involvement of pre-service teachers in nanoscience workshops had an impact on their understanding and awareness of nanoscience. As they got involved with the nanoscience workshops, after participating 1-2 workshops, they started to fill in thegaps in their content knowledge of nanoscience, in other words they started developing nanoliteracy. After taking part in another 1-2 workshops, they started to develop awareness of nanoscience for themselves and started to introduce it to people in their close contact such as family and friends. Pre-service teachers who worked in another 1-2 workshops (totally 4-6), decided to incorporate nanoscience in their personal choices or interests. Finally, the ones who worked in most of the workshops (totally 6-8) developed a more holistic view of nanoscience and wanted to take action to develop and work on bigger, nation-wide, or globally effective projects of nanosicence. In conclusion, taking part in a series number of nanoscience education workshops helped pre-service teachers move through a continuum starting from developing nanoliteracy towards developing of more holistic action taking projects.

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RESEARCH IN STUDENT UNDERSTANDING OF NANOSCIENCE

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The knowledge base of students' understanding of Nanoscience and their potential misconceptions is building up quickly. The varying nature of Nanoscience topics studied makes it difficult to express generalizations, but there are a few well-known areas where students struggle. This presentation gives an overview of a few of such difficulties and showcases our research in attempting to track the development of students' conceptions.

Nature of Matter. Young students may be uncertain of the size of constituents of matter and if there is something else between the atoms[1]. The different nature of matter in bulk and in nanoscale amounts is not easy to understand, and often properties of bulk matter, such as color, are attributed to atoms and molecules[2].

Forces. The relative magnitudes of (more or less) unfamiliar forces determine chemical reactions and are the basis of many research techniques, such as DNA electrophoresis. Students tend to view friction as purely mechanical[3] and have trouble connecting macroscale phenomena to the interplay of forces at nanoscale[4].

Scientific models. Students may see a model as an exact depiction of reality, stripped of its predictive use or its tentative status[5]. Brune et al.[6] point out that nanoscientists, too, often speak interchangeably about objects and their models.

We have designed Nanoscience courses and lessons for secondary school in 2010 and 2011 and lastly, a Nanoscience undergraduate course in April 2012. The goal has been to investigate the progression of students' mental models[7] in various areas of Nanoscience. The student work consists of tasks that require experiments, modeling, drawing and explaining concepts, with the aim to allow researchers a view into students' mental models. The students' group discussions have been recorded and some students were chosen for interviews. I will discuss our results from these years and explore a few interesting cases from the latest data.

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CHEMISTRY STUDENTS' PERCEPTION OF NANO-SCIENCE AND TECHNOLOGY

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Our societies are getting depending on technology for happiness, prosperity, wealth, and a better life[1]. Nano-science and technology are considered modern time industrial revolution because of their effects to our social, cultural and economic life[2]. However, we need a well-educated work force as well as a nano-literate society in order to fully utilize the benefits of nano-science and technology. One of the easy and well-proved ways of accomplish this goal is to integrate nano-science and technology concepts into all levels of the educational system. The first step of this process begins with investigating what students think about nano-science and technology at all levels so that curriculum developers can set better standards and develop curriculum based on them. In this study, we examined college chemistry students' perceptions of nano-science and technology and their effects to our society. An open-ended questionnaire was developed and employed to 100 junior and senior chemistry students. A semi-structured interview protocol was developed based on the questionnaire questions in order to further investigate the participants' views regarding nano-science and technology. The interviews were conducted with 8 randomly selected participants who also took the questionnaire. The data from both sources were subjected to content analysis. Preliminary results of the content analysis revealed that nano-science and technology are not part of chemistry students' daily life. On the other hand, many students associated nano-science and technology with advancement. They could not, however, perceived deep impact of nano-science and technology to civilization and culture. We suggest that nano-science and technology should be integrated into chemistry education at tertiary level by explicitly addressing its chemical applications and effects on our daily life.

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NANOSCIENCE IN SECONDARY SCHOOL? TEACHERS' VIEWS

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Nanoscience is a flourishing field of research and great expectations rest on its applications. Recently, demands have been put forth for providing education in nanoscience already at the secondary level. Besides the forthcoming need for nanoscience-educated workforce in many fields of science and technology [1], it has also been argued that some understanding of nanoscience is required for up-to-date scientific literacy for all [2].

The study presented here addressed these concerns by finding out Finnish science teachers' views of the *educational significance* [3] of nanoscience and the prospects of incorporating nanoscience in secondary school curriculum. Research has shown that teachers' perspectives must be taken into account at an early stage in order to facilitate any curriculum revision or other changes in school practices [4].

First, 23 experienced science teachers who had taken a week-long course on the content knowledge of NST were surveyed on the appropriateness of nanoscience for secondary school curriculum [5]. Qualitative content analysis of the responses revealed that the respondents considered nanoscience as desirable contents for school, but arranging instruction is problematic. The teachers emphasised the *educational significance* of many applications, scientific principles and ethical issues related to nanoscience.

These outcomes were complemented with a larger, quantitative study [6]. This latter study used an online questionnaire with closed questions and focused on teachers' perception of resources for nanoscience teaching. The responses (n=107) showed that the lack of schools' and teachers' own resources hinder incorporating these issues into science lessons, but teacher training, new materials and learning environments would effectively facilitate the process.

In the presentation, potential contents and strategies for nanoscience education at the secondary level are discussed on the basis of these survey results and other literature.

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EXPLORING PRIMARY STUDENT TEACHERS' CONCEPTIONS OF SIZE - DEPENDENT PROPERTIES AT THE NANOSCALE

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The rapid development of nanoscience as a scientific field where the classical domains like physics, chemistry and biology converge and meet at the atomic or molecular level, provoke the science educators' interest to introduce basic ideas of this area into the school science curriculum (Hingant & Albe 2010; Blonder 2011). The emergence of novel mechanical, optical, electric, magnetic, thermal, chemical and biological properties at the nanoscale as compared to bulk behavior (Roco 1999) seems to be a valuable general insight from an educational point of view (Stevens et al 2009). For instance, colloidal suspensions of gold nanoparticles exhibit different colors at the nanoscale depending on particle size. Assuming that nanoscale conceptions held by teachers will affect those of their students in a review of the science education literature one faces a need for research - at least research that links content matter and educational issues - regarding teacher education (e.g. Healy 2009).

The work presented here focuses on size-dependent properties at the nanoscale. In a small group setting of 2 students each, twenty six primary student teachers' capabilities and difficulties in understanding the scientific point of view were investigated, using a teaching experiment design. Teaching experiment is a kind of interview that is deliberately employed as teaching and learning situation. The different colors that exhibit the grains of Cadmium Selenide at the nanoscale were discussed during the interviews (Halliday et al 2001). Student teachers' "explanation framework" as the size of materials approaches the nanoscale will be presented in the conference.

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AN INTRODUCTION TO PROFILES: PROFESSIONAL REFLECTION-ORIENTED FOCUS ON INQUIRY BASED LEARNING AND EDUCATION THROUGH SCIENCE PROFILES

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PROFILES (Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science) is an European FP7 funded project. The consortium consists of 22 institutions from 20 different countries. PROFILES promotes IBSE through raising the self-efficacy of science teachers to take ownership of more effective ways of teaching students, supported by stakeholders. The project is based on 'teacher partnerships' aiming to implement existing, exemplary context-led, IBSE focussed science teaching materials. Long-term teacher training courses reflecting challenges relevant for the participants will raise their skills in developing creative, scientific problem-solving and socio-scientific related learning environments; learning environments which enhance students' intrinsic motivation to learn science and their individual competencies such as proper decision-making abilities and abilities in scientific inquiry. Measures of success are through determining (a) the self-efficacy of science teachers in developing up to date science teaching and (b) the attitudes of students toward science and their science education. The dissemination of approaches, reactions from stakeholders and insights from accompanying evaluation form a further key project target, making much use of the internet and other useful formats. The intended outcome of PROFILES is science education becoming more meaningful, stronger related to 21st century science and to IBSE to foster scientific literacy.

LEARNING ENVIRONMENT FOR THE PROMOTION OF PROFILES

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The PROFILES Learning Environment is to support teachers in the establishment of self-efficacy and beyond that, teacher ownership of, the PROFILES philosophy. The philosophy is seen as guiding teachers to become professions, reflecting on their teaching in utilising effective inquiry learning while recognising the need to educate students rather than teacher the curriculum and hence adopt an education through science focus with the target of enhancing the scientific and technological literacy of students. This presentation illustrates exemplary teacher modules for adaptation by teachers and outcomes from attempts to identify teacher PCK needs for professional support.

FROM THEORY TO PRACTICE: DESIGN AND IMPLEMENTATION OF A CPD MODEL TOWARDS TEACHER OWNERSHIP

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PROFILES (Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science) project, is currently one of the European FP7 funded project in the field of "Science in Society". The project promotes inquiry-based science education (IBSE) through enhancing the self-efficacy of science teachers to take ownership of more effective ways of teaching students. A specific feature of PROFILES is to design and implement a *Continuing Professional Development* (CPD) model which incorporates a relevant inquiry-oriented PCK. A two-step process is suggested: *Step 1,* focusing on meeting teacher needs to develop self efficacy in teachers to utilize PROFILES ideas in their teaching, and *Step 2*, focusing on building on the experiences gained and develop teacher ownership of PROFILES. During the presentation we will report on May 2011 international workshop as a case-study. This workshop model relies on four interrelated fronts, the teacher: (1) as a learner; (2) as a teacher; (3) as a reflective practitioner and (4) as a leader. These four fronts are central for the teacher professionalization process towards their ownership. In the presentation we will describe the goals and features of the professional development. Suggested CPD (continuous professional development) Models to be used in 19 EU nations will be presented and discussed.

EVALUATING STUDENT GAINS IN THE PROFILES PROJECT BY MEANS OF THE MOLE INSTRUMENT

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Intervention projects – such as and especially as large as PROFILES – need to clarify the success of their efforts regarding the projects aims. In the case of PROFILES our intervention and efforts are trying to promote - among other objectives the enhancement of students Scientific Literacy. More specifically, PROFILES aims to promote student gains and thus, the PROFILES project tries to

(a) balance the attitudes of students toward science and the science education they receive,
(b) negotiate the meaning and relevance of science education so that science lessons will become more meaningful in eyes of the participating students,
(c) enhance students intrinsic motivation to learn science and
(d) their abilities and skills especially in the field of learning approaches to science inquiry making justified decisions regarding socio-science and science related issues.

In our presentation we will introduce a theoretically and empirically sound model of teaching and learning science as well as questionnaires and instruments for the investigation of the aims mentioned above. Furthermore we will present and discuss results from different intervention studies obtained by means of the different questionnaires and instruments (mentioned above). The results will be used as examples to offer insights into the potential of the questionnaires and pre-post-intervention-and-control-group design approach. In addition first pre-test data within PROFILES will be presented.

TEACHERS' AND STAKEHOLDERS' NETWORKING IN PROFILES

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PROFILES is a project devised to give teacher ownership of the PROFILES approach to the teaching of science subjects so as to enhance the scientific and technological literacy of students. As such PROFILES recognises the importance, not only of dissemination of developments for the benefit of science teachers across Europe and even worldwide, but also the need for interaction through a networking system at the school, local, national and European/worldwide levels. Networking is seen as the creation of intermediate structures which address, among other things, the fields of autonomy and interconnectedness of structures and processes, parameters and freedoms, as well as voluntariness and obligations. Practice and science teaching try to forge new paths in the formation of learning and the cooperation between people and institutions (Rauch et al., 2009). For the development of the PROFILES networks, theoretical aspects of approaches to social networking concepts need to be addressed. How the PROFILES Consortium tries to reach this aim will be presented in the symposium.

THE EUROPEAN CHEMISTRY THEMATIC NETWORK ASSOCIATION

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The European Chemistry Thematic Network Association is a non-profit making association registered in Belgium. Higher education institutions, national chemical societies, and chemical companies comprise the members. There are currently over 130 members coming from 30 different European countries, and with associate members world-wide.

The aims and objectives of the Association are:

- To implement, consult or supervise programmes for the assessment of skills and knowledge in science and engineering, with the emphasis on chemistry.
- To undertake education and training programmes.
- To operate as a consultant or assessor in programmes concerning education and training.
- To provide certification of achievement, when assessments have been carried out under appropriate conditions.
- To provide a European framework for degrees in chemistry and related disciplines.

In this context, expert European groups work on a range of topics in chemical sciences, and produce reports and recommendations with a real European dimension.

Moreover, EChemTest, a multi-lingual series of on-line tests that can be used for certification and validation of competences in chemical sciences at various levels, is fully operational with the support of ten relevant Testing Centres. In addition, the Association is managing the award of the Chemistry Quality Eurolabels; and is systematically organising intensive schools on analytical measurements applied in cultural heritage preservation.

Details on the activities may be found under: www.ectn-assoc.org.

THE PHILOSOPHY OF THE CHEMISTRY EUROLABELS

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Chemistry was one of the subjects which was involved since the beginning in the project "Tuning Educational Structures in Europe". Thus the Chemistry Subject Area Group in Tuning, run by ECTN, thought and discussed for many years about how chemistry degree structures across Europe could be made compatible.

From there it was a short step to consider the aspect of quality assurance. To set up our own QA labels was however a bigger one!

EUROPEAN QUALITY LABELS IN CHEMISTRY – THE CHEMISTRY DOCTORATE EUROLABEL®

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In order to be fully aligned with the European Higher Education Area overarching framework for qualifications, third cycle degree programmes need to be structured and transparent, while avoiding overregulation.

The Chemistry Doctorate Eurolabel® is a framework for a third cycle qualification in chemistry, largely relying upon the expertise encountered within the European Chemistry Thematic Network Association, a non-profit body including over 130 member institutions in thirty different European countries.

The label is giving great attention to the development of adequate generic and transferable skills; is establishing an open-ended register of experts, based on well-defined criteria and able to deal with all concerns emerging during labelling; and is thus setting up an open-ended Quality Label Network of universities and chemical societies actively involved in the issue. On-line training workshops and a highly interactive information point are offering the support necessary for submitting an adequate application or participating in the awarding procedures.

Overall objectives are to guarantee transparency in access, supervision and assessment procedures; to promote mobility and intensify co-operation; to foster quality assurance for joint doctoral degrees; and to strengthen at an international level the attractiveness of studying and doing research in Europe – that is to support the main issues promoting realisation of the European Higher Education and Research Areas.

The impact envisaged is actually encompassing all chemistry departments of the European Higher Education Area delivering doctoral degrees, and wishing to offer their PhD students a clearly structured context, guaranteeing transparency and efficiency for both local and multiple/joint degrees; as well as any non-European university interested in a European quality label. Finally, the impact may easily concern further disciplines moving towards the creation of similar qualifications frameworks.

ECHEMTEST AND WEB SUPPORT

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EChemTest is the up to date most important asset of EC2E2N and its web service master piece. It is based on a set of electronic web based self-evaluation tests EChemTest provides one-hour tests made of up to thirty questions of different types, taken at random from a large bank, covering the European Core Chemistry Programme at three different levels. These levels correspond to the end of compulsory education, to the beginning of university studies, and to the completion of the core chemistry syllabus in analytical, biological, inorganic, organic and physical chemistry as required for the Eurobachelor® Label. Some tests at master's level are also provided for synthetic and computational chemistry. Moreover, specialized question banks have been created for chemistry applied to cultural heritage preservation, and for chemical engineering (ChemEPass project).

In addition to on-line self-assessment, that greatly enhances the ability of acquiring skills in chemistry, EChemTest sessions are also offered under controlled conditions in eight fully equipped Testing Centres, located at the following institutions: Technical University of Vienna, Austria; University of Helsinki, Finland; CPE Lyon, France; University of Athens and Aristotle University of Thessaloniki, Greece; University of Perugia, Italy; Jagiellonian University of Krakow, Poland; Complutense University of Madrid, Spain; University of Reading, United Kingdom. All EChemTest Testing Centres are run by an educational supervisor and a trained ICT administrator. They award relevant certificates and act as partners for translations, dissemination and initiatives addressed to citizens to exercise lifelong learning.

The EChemTest tests service is offered for free to the Institutions members of the ECTN Association. At the same time a commercial operating environment has been assembled to offer online tests to achieve EChemTest certification for levels 1 and 2 in English language. The service is operated under the Questionmark Perception Server v5 evaluation that offers also the Translation Management System helping the carrying out of assessments in multiple languages by streamlining the management and delivery of localized content to multinational environments.

ECTN ASSOCIATION AND EC2E2N NEWSLETTER: THE 2011 "IYC" WONDERFUL EXPERIENCE AND FEEDBACK

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Since it's beginning, the ECTN Network, its successor EC2E2N, and the non-profit Association ECTN-A is using NTIC tools first among their members, then externally to a wider community, to provide and circulate information about our activities and events. After few years, we started to host external communications and subsequently the dissemination grows up first in Europe then outside. As many, or all, of us, we are using two of the numerous electronic media tools, the Web environment and the e-mails. To serve the communication needs we setup a website portal covering today the main areas of our activities [1]: EC2E2N, ECTN Association, EChemTest, Eurolabels and NewsLetter.

Within the first EU sponsored contract "ECTN1" frame (1997-1999), especially for one of our Working Group, the "Core Chemistry Objective 1" project (today "EChemTest"), we used the regular tools, to exchange information about the progress within the team. The original technical communication slowly becomes an electronic Information Bulletin or News approximately at the time of the official Association was launched (2000). And nowadays, with the help of the Editorial Board [2], the NewsLetter directly reaches a very large community, much larger than ours, with over 550 institutions / universities from more than 67 countries.

The regular editorial schedule is 5 issues per year, but exceptionally in 2011 within the International Year of Chemistry context, we ran a special editorial line with 11 issues hosting Guest Editors. Mainly National Chemical Societies members of the Association were invited to contribute, but we also dedicated 2 special editions, covering first the African-Middle-Eastern Countries and second the South and Central Americas "Latin America". During the conference we will present the feedback of this exceptional programme, and focus on the variety and amazing amount of information related to Chemistry and Chemical Education.

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   EChemTest (European Chemistry Test), www.echemtest.net
   Chemistry Eurolabels, www.chemistry-eurolabels.eu
   ECTNA / EC2E2N NewsLetter, www.ectn-assoc.info
2. Editorial Board composed of 7 members: Antonio Lagana, U. Perugia, IT; Bill Byers, U. Ulster, UK; Evangelia Varella, A.U. Thessaloniki, GR; Iwona Maciejowska, J.U. Krakow, PL; Kristiina Wähälä, U. Helsinki, FI; Pascal Mimero, CPE Lyon, FR; Pavel Drasar, ICT Prague, CZ).

THE ROLE OF MUSEUMS IN CHEMISTRY COMMUNICATION. AN INTRODUCTION TO THE WORKSHOP

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There exist many ways of teaching and communicating Chemistry and they differ with respect to their specific targets, methods and objectives, as well as depending on to the final consumers or public audience. Science Centers and Scientific and / or Technical Museums are very special arena for their multiple possibilities of teaching and communicating Science. In these places, Chemistry can be disseminated by using several tools and methods typical of the Museums. [1-3]

Chemistry can be taught to kids as well as adults, through the hands-on exhibits, guided visits and didactic activities in the laboratory areas. Moreover, the Museums are ideal spaces where to observe and know the Chemical Science in its more spectacular and charming aspects. Recent experimentations have proved the effectiveness of the Scientific Museums as neutral areas where to discuss and debate hot aspects in the relationship between Science and Society, and of course Chemistry and Society.

This is the sense of organizing a Workshop dedicated to “Chemistry in the Museums”.

Among the main objectives of the Workshop:

1. Facilitate the exchange among curators and scientific directors of Science Centers and Museums where Chemistry represents the prevalent part.
2. Offer an optimal contest to discuss about new ways of communicating Chemistry in the Museums.
3. Present recent works and experimentations of teaching activities in the Museums.

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UNIVERSITY MUSEUMS: A PRECIOUS CULTURAL AND SCIENTIFIC RESOURCE

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University Museums represent a precious cultural and scientific resource of our country. The quality of collections, instruments, unique artfacts has been for many years a patrimony with only internal interest, but now around it an increasing social and civil interest is developing. At the same time we observe and other process in our society the tourism always more assumes cultural aspects ant the tour operators on request of their customers insert frequently the visits to scientific museums in their commercial offer and itineraries. In such a context the availability of a network of university museums can be an opportunity to diffuse our cultural history and to run a new way for outsourcing. In order to obtain that this offer is accepted and well enjoyed it is necessary to proceed according to two different guidelines

- structural harmonisation so that itineraries can be designed and performed according to cultural and scientific criteria;
- inventory of the patrimony of each museum and fruitable show of it in order to let understand the meaning of each one of the exposed pieces.

In the case of Chemistry the project must be enriched to point out the three main characteristics of chemistry: creativity, flexibility, inductive character of knowledge. This obliges to implement exposure with lab experiments, instrumental section, modellistic and informatic approach.

TO APPROACH CHEMISTRY WITH AN HISTORICAL MUSEUM

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An historic Museum of Chemistry can contribute to attract to this subject students and young people. In fact through the use of the old original equipments, or also with copies, is possible to show concretely processes and reactions now often hidden by the advanced technology of the instruments. The allure of the ancient instruments is added to this in the case of original equipments. Moreover the thought that the great inventions have been made just by men with tangible objects is an evocative incentive for the new generations. At the Dipartimento di Chimica "Ugo Schiff" of Florence University are conserved some collections of goods related to the nineteenth century chemistry, the most important of these belonging to Ugo Schiff (1). The museum is not open to the public but in occasion of happenings dedicated to the scientific dissemination we have shown some simple experiments with the original instruments, that have met a great success of the public. For example we have used a nineteenth century spectroscope to see the emission lines or bands of several luminous sources (incandescent lamp, neon lamp, candle, solar spectrum) (2). Another possible experience is the thin layer chromatography with which we obtain the separation of some substances contained in a natural or artificial sample, in a very simple and visually satisfying manner.

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CHEMISTRY IN THE DEUTSCHES MUSEUM: A NEW ACCESS TO CHEMISTRY

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At the Deutsches Museum, a chemistry exhibition has been in place ever since the museum was founded. The previous chemistry exhibition was closed in 2009 due to redesign. The new permanent exhibition will be divided into three main areas: in the area of *Historical Chemistry*, replicas of three historical labs - from alchemy times, from the times of Lavoisier and Liebig – will be rebuilt like in all previous exhibitions.

In the *Exhibition Section*, several topics (recreation & sport, nutrition, analytical science, etc.) of modern chemistry will be presented. The key messages are:

- Chemistry is an innovative, responsible science that offers benefits both to society and to individuals.
- Visitors should be surprised about the chemistry surrounding them in their daily life and ask for the background.

The exhibition will use all kinds of museum media such as objects, texts, images and interactive demonstrations.

In the *Laboratory Section*, a modern auditorium and a hands-on laboratory are planned. Adapted to the topics of the exhibition there will be held different programmes and lectures.

We address our exhibition especially to young visitors. Therefore there will be special programmes for pupils and even pre-school kids. The exhibition staff will try to give every visitor the feeling of meeting molecules eye-to-eye.

In the International Year of Chemistry 2011 we opened a part of the new exhibition in the form of a special exhibition. This gives the possibility of the concept to be evaluated.

The very first visitors of the special exhibition *Chemistry in Recreation and Sport*

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NEW METHODS FOR EXHIBITING PLASTIC MATERIAL THROUGH DESIGN, RESEARCH, PRESERVATION AND EDUCATIONAL MEANS: THE PLART FOUNDATION

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The Plart Foundation, a multifunctional space entirely dedicated to polymeric materials, was inaugurated in Naples in 1998. The Foundation premises house a permanent exhibition of one of the richest collections of historical plastics made up of 1500 objects from different periods, specifically from the late-1800s to articles of contemporary design. These are flanked by contemporary displays showcasing designers and artists whose common denominator is the use of plastic in creating their works of art. But defining the Plart Foundation as a "museum of plastics" would be inappropriate and simplistic. In fact, its exhibition activities are accompanied by some intense educational and scientific research activities that are especially aimed at the preservation and restoration of polymeric materials.

The array of these activities - in addition to scouting for new talents who employ these materials in an innovative way - produces excellent conditions for the dissemination of correct information regarding polymers to a vast and heterogeneous public: beginning with elementary school children, university students in Italy and abroad collaborating with the Foundation on different projects, occasional visitors and scholars. The latter also have access to the Foundation laboratories, its specialized library and warehouses where items belonging to the collection and not on display are preserved in excellent conditions. Therefore a place where the extensive and heterogeneous family of plastic material is investigated extensively, according to the most advanced exhibition criteria. The exhibition layout of the permanent collection in fact stresses the idea of a "story" through a great curved display case that is suspended through the vaults of space. Moreover, a multimedia sector has recently been inaugurated. The area envisages strong interaction with the public and illustrates the history of plastic beginning with early chemical experiments and all the way to bioplastics, using recreational methods that are also suitable for children. In setting up the exhibition, the Plart Foundation has done its best to surprise visitors and play with the emotions that plastics, generally considered a poor and polluting material, may generate on the contrary, with the aim of conveying the principle according to which the conscientious use of materials, and polymers in particular, is necessary and possible – thus making the best use of their performance characteristics while safeguarding the environment. The Plart Foundation has done all of this through an innovative staging and the careful selection of items to be showcased.

MUSEUM&LAB PROJECTS AT THE MUSEO DI CHIMICA – DCCI, GENOA UNIVERSITY

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The Chemistry Museum of the DCCI (Dipartimento di Chimica e Chimica Industriale) of Genoa University (http://www.chimica.unige.it/museo/), dedicated to the outstanding figure of Stanislao Cannizzaro (1826-1910), offers to the visitors more than 700 objects, some of which dating back to the first half of the 19th century, in a beautiful original context, where "chemistry" can be breathed from the wood and ceramic of its counters.
Among the manifold activity hinged on the *Museo di Chimica*,[1,2] recently, also thanks to funding from MIUR, from Regione Liguria, and from FEG (Fondazione Enrico Garrone) and the voluntary commitment of a pool of self-made "guides", some Museum&Lab projects have been set-up, which bring classes to the Museum, accompanying the visit (whose specific content can be chosen by the visitors themselves among a few pertinent, purposely tailored historical/didactic proposals, exploiting local competences and expertises) with a laboratorial activity which engages students of every age into real, practical chemistry handling.

The projects below:

Doing Chemistry at the Museum, for primary and lower-secondary schools,
TechToSchool, for upper-secondary schools,
PNLS (Progetto Nazionale Lauree Scientifiche), for the last two years of upper-secondary schools.

will be presented and evaluated on the grounds of the satisfaction expressed also by means of questionnaires filled in by students and/or teachers.

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"RESEARCH AID" - ARISING SCHOOL CHILDREN´S INTEREST IN SCIENCE?

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In order to increase the interest for learning natural sciences in secondary school, the project "Forskarhjälpen" (or "Research Aid") was initiated in May 2011 by the Nobel Museum in Stockholm, Sweden. The project gives school children (13-15 years old) the chance to be active partners in an authentic research project. "Research Aid" is in collaboration between the Nobel Museum and Laboratories for Chemical Biology at Umeå University (LCBU) in Sweden.

One of the aims of the School and Research Departments at the Nobel Museum is to raise interest for science in school children at primary and secondary level. This is done by offering special school programs that pupils can attend at the museum. The project "Research Aid" takes this aim even further. The project is not only set to inform pupils about research projects, but to let them assist the researchers in the research process that eventually will result in scientific publications or presentations. One of the research projects at LCBU is searching for novel secondary metabolites produced by the bacterial group Actinomycetes, aiming for molecules with antibacterial/anti-virulence properties. Actinomycetes are to be found everywhere in nature, and in order to find species producing novel metabolites, the researchers needed help. This was the task for the school children from about 20 classes distributed all over Sweden - a hunt for actinomycetes preceded in the footsteps of Sir Alexander Fleming, who discovered the penicillin and was awarded the Nobel Prize in Physiology or Medicine in 1945.

The pupils were given the task to collect soil samples, isolate bacteria from the soil, make simple characterizations, document their findings in a scientific poster and report back to the researchers. The analyses were made in close contact with the scientists at LCBU through the homepage of "Research Aid". Different species of actinomycetes were found, from which extractions were made in order to investigate the antibacterial activity. LBCU now has a "library" of extracts for future studies. A poster competition was also announced and as reward the winners were given tickets to the awarding ceremony of the Nobel Prize 10th of December 2011. The posters were published on the "Research Aid" webpage and votes were counted by most "likes" through Facebook. More than 5000 people voted for their favorite poster and thereby the word about "Research Aid" was spread to a larger audience. "Research Aid" is financed by the Swedish Foundation for Strategic Research.

COGNITIVE COMPLEXITY AND STUDENT PERFORMANCE ON CHEMISTRY TESTS

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When students complete tests, from the cognitive perspective, they are accomplishing a series of tasks. Each item represents a new cognitive assignment, and there are factors beyond the chemistry content itself that influence the approaches taken by students. One key factor in student performance on a test item is the overall complexity of the item. This basic concept has been noted as important in the Information Processing Model of Johnstone and coworkers[1,2]. While this concept has been investigated in research studies, the role of complexity in large scale testing applications in chemistry has received less attention. Obtaining a measure for the latent trait of cognitive complexity from measurable features of test items presents content-based challenges and requires careful statistical analysis. This talk will describe processes and methods that have been developed to parse the cognitive complexity of test items using expert rating systems to assign a form of objective complexity and student self-ratings of mental effort as a proxy for subjective complexity. These measures, along with performance on the items is then analyzed using factor analysis and structural equation modelling to elucidate the role that complexity plays in establishing what is measured when a student takes a chemistry test.

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A PHENOMENOGRAPHIC STUDY OF PROBLEM SOLVING IN CHEMISTRY CAPITALIZED

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This paper describes a phenomenographic study of how chemistry undergraduates approach open-ended problem solving activities. Phenomenology aims to identify the different ways that individuals experience a phenomenon. In this study, it was used to identify the different ways that students experienced solving open-ended, context rich problems. Phenomenography assumes that there are a limited number of qualitatively different ways in which different people experience the same phenomenon. The outcome of a phenomenographic analysis is a set of categories that describe the different ways in which the research subjects experience, interpret or understand an experience or activity.

"Pure" phenomenography is concerned with describing the diverse ways in which people experience conceptions of a phenomenon[1]. "Developmental". phenomenography seeks to find out how people experience some aspect of their world, and then to enable them or others to change the way their world operates[2.] As this study seeks to identify the different ways that students experience solving open-ended problems in chemistry with a view to provide insight that will help their tutors change how they and subsequent students approach problem solving, the approach used in the study is developmental phenomenography.

The study involved individual students solving open-ended, context-rich problems using a think aloud protocol. This took place on one to one sessions with the researcher. Students were encouraged to verbalise their thoughts and to write as much as possible whilst solving the problems. Care was taken not to provide help with the problems themselves. The sessions were recorded and all problem solving scripts retained for later analysis. Analysis of the interview and scripts resulted in a limited number of categories of approach. The analysis then ascribed approaches to individual students. The results show that there are three main types of problem-solver. These results have implications for how academics view 'problem solving skills' in general and how open-ended problems are utilised in teaching.

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SCALE LITERACY OF STUDENTS IN FOUNDATION-LEVEL CHEMISTRY COURSES

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Grasping scale outside the visual realm can be difficult with regards to the very small. Students in chemistry courses are required to begin thinking about concepts in chemistry on a particle level. The development of a student's scale conception outside of the concepts of chemistry has been noted as an important component of a student's overall science literacy[1,2]. Research shows that students need to continue cultivating their understanding of scale beyond their elementary and secondary education years[3-5]. Scale literacy of students in general chemistry was examined first using one-on-one activities and semi-structured interviews. Recently, we have conducted these interviews using a head-mounted eye tracker to examine for fixations and time on task for these activities. This led to the development of two instruments to assess scale literacy of students in general chemistry. The predictive power of these instruments has been compared to more traditional predictive measures in general chemistry (e.g. math proficiency). Additionally, adaptive supplemental instruction has been developed to increase the students' scale literacy as it applies to general chemistry.

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COGNITIVE LOAD IN DIFFERENT LEVELS OF REPRESENTATION OF KNOWLEDGE IN CHEMISTRY

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Chemistry is often regarded as a difficult subject and its study therefore imposes high cognitive demands on learners. One of the possible sources of difficulty could be the way of presenting abstract chemical concepts, that is to say their presenting at several levels only one of which can be easily observed [1]. These levels are commonly referred to as *microscopic, sub-microscopic* and *symbolic*. They are linked and all together contribute to meaningful learning and understanding of complex chemical phenomena [2–6].

The purpose of this study was to investigate students' achievements and cognitive loads in different levels of knowledge representations in chemistry. Students were solicited for voluntary participation. A sample included 43 undergraduate chemistry students of Faculty of Sciences, University of Novi Sad. A test was used as a measuring instrument for evaluation of knowledge. Each task contained three subtasks, one in macroscopic, one in sub-microscopic, and one in symbolic domain. Each subtask included a seven-point Likert scale that provided respondents to rate items ranging from "extremely easy" to "extremely difficult".

Parallel analysis of obtained results has shown that the students' evaluations of cognitive loads are in accordance with the accomplishments achieved on the test. Students have estimated that the greatest cognitive load corresponds to sub-microscopic level, which resulted in the lowest achievements. The results have also shown that there are no major differences in the average students' achievements in macroscopic and symbolic level, which is also in line with evaluated cognitive loads. Therefore, we can conclude that students are able to review the cognitive processes and to evaluate the difficulty of the task.

Acknowledgement. This work has been supported by Grant No. 179010 from the Ministry of Education and Science of The Republic of Serbia.

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USE OF WORKSHEETS WHEN TEACHING/LEARNING ABOUT MIXTURES

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This study was designed to determine whether worksheets can be used to teach/learn mixtures effectively to the fourth grade Turkish students. The concept of mixture is thought of fundamental of science (chemistry) program and an appropriate understanding of which is very important for further education[1]. Due to some misconceptions, students may not understand the mixtures and related concepts such as atom, element, molecule, and compound[1]. Elementary fourth grade level, where the mixture and related concepts are first taught in Turkish schools, is also important in science education[1]. Well designed teaching materials such as worksheets can be used to facilitate construction of the concepts in students' minds[2]. Worksheets can also be used to guide students on activities and if they include experiments regarded as hands-on develops positive attitudes towards science on students[3]. Worksheets When responses to the worksheets are analysed the students' conceptions can be revealed.

In this study, 70 students attending into two classes at the same school were divided into groups consisting of four to six students. Each group were given a worksheet and some matters so that they could form many mixtures and separate them. The worksheet questions were concerned with the mixtures, and how their elements or molecules are separated. When the answers of the student groups were analysed, it was found that although the students explained the concept of mixture and separation of mixtures in textbook terms, they gave more free responses to the questions such as how they separated the elements or molecules of a mixture, whether the way they used in separating a mixture is used in daily life. It should be noted that because worksheets provide positive attitudes such as curiosity, thinking, and reproduction[2], the students were very creative in their responses. When used in group activities, worksheets have a positive effect on some attitudes such as cooperation, sharing, and researching among students[2]. These factors in the long term might result with students' ability to answer correctly the similar questions on the same concept although nearly a year passed after the study as noted by their own teachers.

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TITLE: PROCESS ORIENTED GUIDED INQUIRY LEARNING (POGIL) IN FOUNDATION CHEMISTRY: A PROGRESS REPORT

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The purpose of this session is to introduce the POGIL (Process Orientated Guided Inquiry Learning, Moog, www.pogil.org) approach and to report on the outcomes of an action research project in which POGIL was introduced in Foundation Chemistry. Students come to our program with some experience with problem solving, however they have little experience with conceptual fundamentals in chemistry, such as bonding and representations. The POGIL approach was chosen over others because it does not have to be implemented as a predominant teaching style but as it suits the topic, instructor and students. POGIL was chosen above PBL (Problem-Based Learning) and PLTL (Peer-Led Team Learning) as it was an easier transition with the materials readily available and no restructuring of the course or curriculum required. POGIL, a student-centred approach to instruction, structures small groups with questions and tasks that require deep conceptual engagement. This group work helps to break down several cultural barriers for our student's first co-ed university experience.

Was the approach effective? We compared student performance on the same assessment over two years, the latter in which POGIL was used to teach more than half of the course topics. Although the class of 17 students came with similar academic records, their achievement was greater in the POGIL year. A survey to assess student perception of their learning reveals mixed preferences, and their responses suggest that they may be unaware of how much they are learning. More than half still preferred the lecture style. The instructor's qualitative assessment is that the students in the POGIL year became comfortable working together in mixed groups much earlier than they had in previous years. Overall this experience is very similar to other POGIL practitioners in that students show a definite improvement in spite of some resistance. (Rajan & Marcus 2009; Geiger, 2010).

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INTERNATIONAL YEAR OF CHEMISTRY EVENTS AT THE BELARUSIAN STATE UNIVERSITY

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The International Union of Pure and Applied Chemistry announced 2011 the International Year of Chemistry, pronouncing its motto as "Chemistry is our life and our future". This was the year when the Belarusian State University hallmarked its 90th anniversary and 80th anniversary of the Faculty of Chemistry. The Global Experiment addressed to chemical solutions of water issues was specified by us as one of the main events of IYC. The Faculty of Chemistry and BASF Representative Office in Belarus held the Master-class to help the teachers of secondary schools to encourage pupils for participation in Global Experiment. Special website, on-line map of Belarusian water resources pH were created, new data for water structure were obtained [1-3]. The Faculty of Chemistry accents the importance of the young people participation in the solving of water issues. Annually it has initiated the organization of the educational youth Forums: "From a decade of healthy water to a century of healthy life", "Water, climate change and human health", "World of Water Technologies". The great attention to youth Forums is not occasional because mission of the world, humanism and sustainable development propaganda in a society is intended for young generation.

IYC also celebrated 100th anniversary of the Nobel Prize award to Marie Sklodowska-Curie. Belarus is a new comer country in nuclear energy area. Taking into account that nuclear science as an interdisciplinary field requires the cross-cultural relations and the communication expertise of the English language, the language of international exchange and knowledge transfer the BSU lectures put forward the book "Nuclear Chemistry: improving professional skills in English". The book is devoted to IYC. A book like this one is in the unique position of being simultaneously "advanced" and "introductory". It is advanced in the sense of building on grammar and lexical rules as well as collocations important for non-native speakers of English and introductory in the way as acquainting students with the scope of Nuclear Chemistry.

The enthusiasm of students, professors, researchers of the Belarusian State University, the contribution of BASF Representative Office in Belarus promoted an awareness of the importance of chemistry for Belarus development, its positive image for our society and significance to the well-being of humankind.

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GLOBAL STAMP COMPETITION

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Among the arguments for fostering an adequate understanding of Nature of Science there is also a cultural argument: "Science is a major cultural achievement; everyone should be enabled to appreciate it" [1]. This was the starting-point for a IUPAC-Project within the Committee of Chemical Education (CCE) on a project which gave a new meaning to CCE (Chemistry as a Cultural Enterprise). In general the project aimed at intercultural reflections on chemical developments in order to foster better understanding and appreciation of chemistry as a human and cultural enterprise [2, 3]. In IYC 2011 it was realized as a Global Stamp Competition (GSC), encouraging young people to reflect on national chemical developments and to document their reflections by creating a stamp.

To start at the end, during the IYC 2011 Closing Ceremony in Brussels we showed the results, a selection of the 247 designs from 18 countries all over the world [4]. Due to the CCE budget, a generous gift from GlaxoSmithKline and many collaborators (ECTN, IKM, ACS) this result could be realized. Crucial was the support of Jeff Howson, manager of the MTN network (UK), who let us use the moderated publication platform, including the peer review possibility.

It took some time to mobilize helpers within CCE, teachers associations and contacts from former projects. As soon as the first designs were submitted, students/teachers saw examples and could review them. We received pictures of hand drawn designs and results from advanced graphical programs!

In many countries the impact of the competition was substantial [5], e.g. nominees honoured in Egypt, customized stamps in Cyprus and the Netherlands, invitations for official Chemical Society prize giving ceremonies in Malaysia and a complete 'happening' in Gorna Malina, Bulgaria [6] with the whole school with students, (grand)parents, Mayor, Ministry of Education, Inspection of Chemistry, radio and TV present!

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LEARNING FROM THE EXPERIENCE – THE GLOBAL WATER EXPERIMENT IN DEVELOPING COUNTRIES

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There is no doubt that the prospect of participating in a global chemistry experiment was attractive to many teachers and learners in developing countries. The fact that the Global Water Experiment (GWE) provided hands-on experience and allowed teachers and learners in remote parts of the world to form part of a scientific community, would have been sufficient motivation. Considerable efforts were made to provide schools, both locally in South Africa and abroad, with low-cost microscience equipment, suitable experimental protocols and in some instances training on how to do the activities. In the paper the authors will present results of an investigation to look at participation and data received from schools in the developing world, with such reflection serving to guide the future legacy of the International Year of Chemistry.

COMMUNICATING CHEMISTRY: A VIDEO PRODUCTION EXPERIENCE OF CHEMISTRY EDUCATORS IN THE PHILIPPINES

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Science is viewed by many as a "province of the privileged few". Because of this, it is not seen as being relevant, even if people admit that science is beneficial and key to development. So, how could it be effectively communicated?

At present, there are television programs in the Philippines that attempt to do this, however there are feedback that these are not quite successful. Either viewers think that these are too raw and diluted where scientific knowledge is reduced to trivial pursuits and, riding on the host's celebrity status, are meant for winning the "ratings war"; or, are virtual television versions of textbooks, which are full of information but are uninteresting, boring, and bereft of relevance. To the more discerning, these attempts may pose more danger in the sense that it tends to trap viewers in the archaic model of intelligence: the encyclopedic kind.

Based on these observations, two chemistry educators in a Philippine university embarked on producing a video documentary that embodies characteristics that were blended well-enough so that it would be appreciated and, at the same time, learned from. These chareacteristics are: (1) uses the Filipino language; (2) tackles topics that are usually viewed as taboo in classrooms; (3) uses a healthy dose of humor; (4) discusses and synthesizes the various dimensions of the topic [culture, history, health, nutrition, man-on-the-street opinions, and of course, chemistry] via experts from the corresponding disciplines; and (5) do-it-yourself activities for the viewers.

The result is the video-documentary about alcohol, and is entitled "Alak Pa!" ("More Wine!"), which serves as the pilot episode of a proposed series "Kodigo" ("Cheatnotes").

HUMPTY DUMPTY AND THE FIRST YEAR ORGANIC CHEMISTRY CURRICULUM

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In the children's book *Through the Looking Glass*[1] by Lewis Carroll, Alice informs Humpty Dumpty that "The question is……whether you *can* make words mean so many different things". Students entering a first year university organic chemistry course likewise encounter a bewildering diversity of chemical structures, equations, and symbols, and this content is usually set against the backdrop of energetics and kinetics, important physical concepts that are often poorly bedded down in their knowledge base at this early stage of the university curriculum. The volume of material presented can also be very intimidating to students.[2] With large class sizes (>1000 students) hindering the individual tuition that facilities learning, students frequently "have a great fall" (as indeed did Humpty Dumpty, "off a great wall"). Too often they then choose not to continue with organic chemistry. Can we prevent this?

In this paper, we describe the structural changes that have been introduced to better engage our first year students with learning organic chemistry in their first semester of tertiary study. For example, we emphasised the need for students to understand the representation of organic structures, mechanisms, and stereochemistry, and used modern tablet devices to enhance situated learning. Course content was reviewed for appeal to a broad range of students with differing interests, and to assess the vertical integration with later year courses.

How well did we succeed? Comparative exam performance data from the 2012 and 2011 cohorts of first year chemistry students at The University of Queensland are presented.

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A CONTEMPORARY VIEW ON CHEMICAL EQUATIONS - HOW TO TEACH AND WHY

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As the rest of the sciences, chemistry is also a developing and changing subject. This means that our understanding of the fundamental concepts and terms is changing. But, while the science is changing fast, our school systems are generally inert to change. Nonetheless, it is imperative to change the ways we teach. A century ago the minds of chemists and especially of chemistry teachers, operated on the macroscopic level. It means that one would say: Take the compound A, heat it, and it will transform into the compounds B and C. Slowly, the atomic hypotheses took over our minds and we succeeded to explain the macroscopically observed changes in terms of events that occur on atomic (molecular) level. So, we started to teach chemistry accordingly. Generally speaking, the idea behind chemistry was to obtain new compounds - those that are built up of specific and new molecules. During last several decades the minds of chemists changed again. Modern chemists think and operate entirely on a molecular level. We are designing strategies to form targeted supramolecular arrangements and nanoscopic objects that will produce specific micro- and macroscopical physical and chemical properties. The paradigm has changed.

Although it might take time, an analogous change should also follow in the classroom, *i.e.* the minds of chemistry teachers should change. Our chemistry classroom should transform itself at all levels but especially at the introductory level, where central concepts such as chemical equations are shaped. But we should be wary that changing classroom means helping teachers to affect the change, rather than changing the curricula.[1]

This presentation will discuss a *teaching strategy in action* that helped us identify the problems we will face in attempts to affect the change. It also helped us to recognize the benefits we might achieve. For instance, many difficulties are caused by addressing symbols[2] rather than chemical species, and many are caused by preserving old-fashioned meanings of these symbols. It will be shown how changing these particular issues leads to a measurable and positive effect, as well as how this teaching strategy connects to and influences the higher-level concepts, such as chemical equilibria and chemical kinetics.[3,4]

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IN SEARCH OF PROFESSIONALISM IN THE FIELD OF CHEMISTRY EDUCATION IN CHINA: THE STORY OF ZHIXIN LIU

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In China, science educators as a professional group were originally referred to those academic staff responsible for teaching the subject-based science teaching methods course at the related science departments at teachers' universities. In this study, I employed a biographic method to approach the professional life of Zhixin Liu, who was a senior science educator at the department of chemistry at Beijing Normal University (BNU), to reveal how he has come to be a professional science educator and what influences he has brought about to the chemistry education community over the past half a century in China. The main findings of this study were the two roles played by Liu in the enterprise of chemistry education in China: as an agent to disseminate national curricular policies; and as a scholar to construct the Chinese theories of chemistry teaching. Results show that the two roles were intertwined during the whole professional life of Liu. The implications of Liu's life story for dealing with the relationships between policy and practice, theory and practice in the field of science education are discussed.

"AIR AND ATMOSPHERIC POLLUTION" IN SENIOR NATURAL SCIENCE CLASS: AN EMPIRICAL STUDY AND A RESULTANT LECTURE SERIES

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Nowadays, atmospheric pollution is an actual topic which also concerns adolescents and their future. Therefore, they should know how to explain and prevent global phenomena such as the anthropogenic greenhouse effect, the ozone hole and ozone smog, as well as acid rain (which is still an actual problem e.g. in China). As the understanding of these topics requires a significant amount of chemical knowledge, chemistry class is the perfect environment for their acquisition, just as stated [1].

Asking adolescents about their understanding of chemical topics, misconceptions are a common problem [2].

In this context, we conducted a survey with approximately 1.500 tenth and twelfth grade students from Germany, Spain, Taiwan and Russia, as well as 100 German university students specialized in chemistry didactics. Particular emphasis was put on the technical knowledge, possible misconceptions and the attitude of the participants towards environmental protection. "All air pollutants are greenhouse gases." - "The greenhouse effect is caused by the ozone hole." - "Acid rain provokes chemical burn and cancer."… Those and other misconceptions, amongst a significant general lack of knowledge, were discovered by this survey [3].

Based on these findings, a lecture series was developed and tested in chemistry class on German secondary school level students throughout a period of nine lessons. The learning progress was documented via pre-, intermediate- and post-tests. Comparing the positive results of the lecture series with the lack of knowledge of other (even older) students, the necessity of the official incorporation of these globally relevant topics in class becomes evident.

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FREE AND OPEN SOURCE TEACHING-LEARNING MATERIALS FOR AN EXCITING LEARNING EXPERIENCE

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The scope for learning subjects in our own way via flexible learning module is relevant in this age of tablets. The paradigm shift in globalized learning using multiple sources is reflected in the recent trends, practices and techniques among students/facilitators. The present situation of academic non-performance needs some specific and alternate methods to discuss a subject, impart knowledge, instill basic values and for total education. The power point slide show involving sights and sounds on a variety of science, engineering and technology topics offers significantly more visually stimulating experience than traditional teaching tactics. The papers published in open source journals incorporating quality teaching-learning content by specialists in subjects with a significant involvement in subject information provide an alternative source of knowledge. These methods stir the imagination to influence the thoughts and deeds of the future generation and have implications in health, education and prosperity with the advantage of subject areas, supplementary reading material and value addition. The disciplined learners can use visualization technique as a primary method of learning to gain knowledge and understanding to increase confidence levels in the changing times.

CHEMISTRY TEACHING EFFECTIVELY WITH MULTIMEDIA AND LATEST TECHNOLOGY

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It is often to our advantage as teachers to use many different formats and modes to teach the subject matter of a lesson. This is why teachers normally use some combination of lecture, text and hands-on laboratory for conveying information. With the advent of the Internet and the multiple formats that can be communicated over the World Wide Web, we now have several new and exciting ways to present information. Pictures and animations help bring to life scientific principles, and multimedia allows students to take a more active role in learning: they can watch experiments in action, see microorganisms up close, and use a mouse or keyboard to navigate images, simulations and interactive material. One of the goals of Vision learning is to provide just such a resource. Multimedia presentations keep students alert and focused.

Computer-based multimedia also helps students to develop technical and research skills that they cannot get from reading a textbook. The purpose of teaching is learning. A lecturer only teaches what he or she considers important and difficult in the lecture. We have neither the time nor the energy to teach everything. However, students want and need to know everything. To paraphrase the old saying, we should be teaching them ‘fishing' not giving them a‘fish'. We should encourage students to become active and lifelong learners. We need to focus on students' characteristics and their learning styles. When we prepare a lecture, we need to understand what students want to know and what they need to know. Learning is not only active and cumulative, but also integrated and connected.Chemistry is a central science and in the 21st century, it has become more and more important. In other words, chemistry is increasingly permeating other sciences. At the same time, current and future problems become more and more complicated.

THE GREENING OF THE CHEMISTRY CURRICULUM: INTERNATIONAL COOPERATION "BELARUS-V4 COUNTRIES"

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Universities are changing in a fundamental way, moving from the model of the science-based university into the Third Generation University or 3GU for short [1]. 3GUs actively collaborate with industry, financiers and other universities via their know-how hub. Universities operate in an international competitive market and they are experimenting with new forms. In this situation university curriculum is undergoing major changes and developments.

Chemistry is assigned to those natural sciences which make up the basis of the university education. Nowadays it is essential that students are taught to view chemistry with a green tint. To meet changing industry and society requirements the course "Introduction to Green Chemistry: Belarus and V4 countries" has been proposed as an obligatory for the greening of the chemistry curriculum. Today the chemists call "a green chemistry" any improvement of the chemical processes that influences on the environment positively. There are three main directions of the green chemistry development including new methods of synthesis, the replacement of the traditional solvents by safety solvents and the usage of the renewable resources instead of oil [2]. However, nowadays the ideas of green chemistry exceeds the limits of chemistry itself and widespread for the different fields of science. Green chemistry is a revolutionary philosophy more than a new discipline. The aim of the designed course is acquainting students with green strategy in this new field of the chemical knowledge with emphasis on Belarus and V4 countries. The special attention is paid to the universal role of green chemistry in the individual development of the chemical disciplines. The importance of green chemistry is demonstrated for the development of other natural sciences and humanities sciences as well. The program of the course has been designed by the specialists in the field of chemistry, ecology, labor protection and humanities sciences. It is the incarnation of the interdisciplinary communication principle. The course will provide a close collaboration with industry and universities of V4 countries by inviting specialists and field trips organization.

Thereby the international cooperation in the frame of the course "Introduction to Green Chemistry: Belarus and V4 countries" approved by the International Visegrad Fund [3] will create special facilities to meet requirements for 3G University.

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OVERVIEW AND FIRST FINDINGS OF THE PROFILES CURRICULAR DELPHI STUDY ON SCIENCE EDUCATION

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In order to disseminate a modern understanding of scientific literacy, an important consideration of the PROFILES project is the need to bridge the gap between the science education research community, science teachers and local actors and thus to establish an exchange between science teachers, science education researchers and other local actors (Bolte et al., 2011). In order to collect different stakeholders' views and opinions, all PROFILES partners carry out a curricular delphi study (Bolte, 2008; Osborne et al., 2003).

The aim of the PROFILES Curricular Delphi Study on Science Education is to engage at least 100 stakeholders per institution in reflecting on contents, approaches and aims of science education. The outcomes of this study will be used to prepare continuous teacher training courses aiding the implementation and dissemination of PROFILES ideas and objectives to facilitate the uptake of innovative science teaching and the enhancement of scientific literacy (Bolte et al., 2011).

The stakeholder samples of the study consist of 4 main groups being directly or indirectly involved with science and science education respectively: Students with science subjects (1), Pre- and in-service science teachers (2), science educators / researchers / didactics (3) and scientists / others (4). The PROFILES Curricular Delphi Study on Science Education is structured into three rounds. The first round collects the participants' ideas about aspects of contemporary and pedagogically desired science education in three open questions regarding motives / situations / contexts (Q1) as well as fields / methods (Q2) and qualifications (Q3).

In the first round of the study carried out by 19 different partners of the PROFILES project in their respective countries, around 100 stakeholders per partner/institution and all in all more than 2300 stakeholders were involved. The participants' statements of the first round were processed through qualitative and quantitative analyses at the different institutions. The working group at the Free University of Berlin developed in the course of the qualitative analyses a classification system for the analysis of the stakeholders' statements that contains 88 categories regarding desired aspects of science education. The results of the quantitative analyses show several distinctions between the opinions of the different sample groups, which could benefit the development of learning and teaching materials as well as the development and organization of teacher training.

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STAKEHOLDERS' VIEWS ON SCIENCE EDUCATION IN FINNISH PROFILES PROJECT

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Curricular Delphi Study engages different so-called stakeholders in reflecting on contents and aims of science education focusing on those aspects of science education that are considered relevant and pedagogically desirable for the individual in the society of today and in the near future (Bolte 2008; Osborne 2003). This study is a part of the EU 7th FW Project PROFILES (Professional Reflection Oriented Focus on Inquiry-based Learning and Education through Science) and the participants (190) were upper secondary school students, teacher students, science teachers, science teacher educators, and scientists. The three-parts of the questionnaire referred to contexts, situations and motives as well as to fields and qualifications respectively. The responses were analyzed by data-based content analysis using ATLAS-ti program. The final classification system consists of a total number of 85 categories.

Scientists pointed out ethical choices and situations at school as a starting point in science education, themes such as evolution and genetics, and societal issues as an important perspective, as well as skills to innovate as an important qualification. Science teacher educators preferred interest as a starting point as well as societal involvement, themes such as basics of science and ecology, and energy issues as a perspective. Respect for the nature, knowledge in general and/or of energy and problem solving skills were seen to be important. Teachers pointed out that technology and traffic as well as physics issues are relevant contexts for science education. Themes of physics were stated relatively often and water was seen as a relevant perspective. Teachers preferred the ability to make healthy choices and pointed out knowledge in general and technical and ICT skills. Furthermore, students highlighted mainly managing in nature, health and medicine as well as accidents as situations for science education. Learning about plants, berries and mushrooms as well as about animals was for them important as well as first aid as a perspective. Qualifications which students often expressed were interest in science and to contribute for safety. Students highlighted knowledge to be able to act and make choices as well as to learn to exploit or apply.

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ASPECTS RELATED TO THE CONTINUOUS PROFESSIONAL DEVELOPMENT OF CHEMISTRY TEACHERS STATED IN THE FRAME OF PROFILES TRAINING PROGRAM

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In Romania, the teaching career represents an important objective of the *National Strategy of Development*, being strong related to the training process of the school personnel. It is important to emphasize that during the last years it was imposed moreover the need of continuously training of the teachers, both on theoretical and practical aspects. In fact, the success of the reforming process (in primary and secondary Romanian education system) depends on the continuously teachers' professional development, especially done in the frame of several programs who aim to gain specific competences for teachers.

In this sense, the "*PROFILES - Education through Sciences*" training program is oriented on the improving of teaching activities, being organized in the frame of the European Project "*PROFILES – Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science*" (code: 5.2.2.1-SiS-2010-2.2.1-266589), which has as objective to promote reflection-oriented teaching - where this enhances students' scientific literacy -, and to design a collaborative network, able to offer to Science teaches and researchers the possibility of active cooperation by promoting ideas and specific training materials, spreading the best practices, seminaries, workshops etc.

In this sense, the mentioned training program was developed and accredited - at national level - with the declared aim to response to a clear necessity for Romanian Science teachers on promoting training reflection-oriented, pedagogical and scientific competences, *Inquiry-based Science Education* (*IBSE*) and related approaches which can be implemented in the educational environment. At the same time, the proposed training program, answered to the conclusions of the curricular *Delphi Study*, performed in the frame of *PROFILES* project, that involved in Romania more than 100 stakeholders in reflecting on contents and aims of Science Education as well as in outlining aspects and approaches of modern Science Education.

The present paper illustrates the main aspects of the PROFILES continuous professional development in Romania, its specific background and components, as well as two examples of proposed conceptual framework (Modules) for teaching Chemistry / Science at secondary level, based on the *PROFILES* model.

TEACHING ABOUT 'STEVIA' – AN EXAMPLE OF COOPERATIVE CURRICULUM INNOVATION WITHIN PROFILES IN GERMANY

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It took a long time that 'Stevia' was approved within the EU to be allowed using it as a low-calorie-sweetener. But: What is Stevia? How can we inquire Stevia? Is Stevia a good sweetener? How were we dealing with the Stevia-debate in society? To whom might Stevia become a potentially attractive alternative? …

Developing and implementing innovative teaching materials incorporating a societal perspective on science education and compassing inquiry-type lab-work are among the aims of the FP7-project "PROFILES – Professional Reflection Oriented Focus on Inquiry-based Learning and Education through Science" founded by EU (1). Lead by the Free University of Berlin, PROFILES is built up by 21 partners out of 20 countries from all over Europe. The University of Bremen (UniHB), Germany, is one of them. Within PROFILES UniHB is operating a Participatory Action Research-based approach of curriculum innovation and professional development (2). Teams of science educators and teachers jointly develop and implement societal driven and inquiry-based lesson plans inspired by a socio-critical and problem-oriented approach to chemistry and science teaching (3).

This presentation will provide a short description of how PROFILES is driven in the case of the UniHB. It will be discussed how curriculum development and teachers' CPD are jointly operated. The work of PROFILES at the UniHB will be illustrated by the case of developing a lesson plan on sweeteners in general and 'Stevia' in particular (4). Exemplary insights will be provided how the cooperation of educators and teachers within PROFILES at the UniHB leads to the implementation of a different approach to chemistry learning. This approach aims on more student activity and the development of new teaching methods. In this case a method was developed to learn about the role of chemistry within the making of advertisings for science related products. Initial insights into the effects of the lesson plan will be presented.

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THE ECTN AND EC2E2N NETWORKS – PAST AND PRESENT

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The European Chemistry Thematic Network (ECTN) was created in 1996 in response to a call for proposals by the European Commission under the Socrates-Erasmus programme. Since that time the network has been continuously funded by the European Commission, and we are currently on the fifth 3-year project, funded under the Erasmus action of the Lifelong Learning programme, which is entitled the European Chemistry and Chemical Engineering Education Network (EC2E2N).

The role of the network projects is to bring together all the actors in higher education in chemistry and, since the start of the current project, chemical engineering, thus providing a European forum for all topics concerning this field.

This presentation will serve to introduce the major activities of the network since its inception and briefly outline the work currently being carried out and not presented in the subsequent presentations in this session.

Past activities have included the definition of what constitutes core chemistry in bachelor (first cycle) programmes throughout Europe, participation in the Tuning Educational Structures in Europe projects [2], links between universities and schools, recently appointed university chemistry teaching staff, the interface between chemistry and chemical engineering, the employability of first-cycle chemists, and many more topics.

The current network project, EC2E2N [1], has 118 partners coming from 27 European countries, with three associated partners from outside Europe (Egypt, Russia, and South Africa). The partners are mainly university chemistry or chemical engineering departments, but also include the chemical industry, national chemical societies, and an accreditation agency. This project will end in September 2012. A new project has been submitted. If it is funded, a brief presentation of future activities will be made.

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E-CHEMIST: A VIRTUAL EDUCATIONAL COMMUNITY

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A mission of the European Chemistry Thematic Network (ECTN) [1] is to build e-CheMIST an e-environment devoted Chemistry and Molecular Innovation, Science and Technology and bound to provide related "integrated services through unified access to and seamless integration of the underlying networking, computing and data infrastructures" to the general public and to young generations, in particular, for teaching and learning [2].

A highly innovative front of the proposed e-Science environment is the pursuing of a long term sustainability by adopting a Virtual Educational Community approach to foster collaborative endeavours in teaching and learning (T&L) and on the use of some monitoring tools of the European Grid to carry out an evaluation of the quality of the services offered and of the quality of the users. The evaluations made using these parameters will be employed to reward the efforts of the individuals on behalf of the community [3].

Leveraging on the specific features of grid platforms in terms of distributed concurrent elaboration, data storage, software reuse and interoperability, repositories of higher education electronic teaching and learning (T&L) materials and Learning Objects (LO) are being created building up a Europe wide virtual campus [4].

The up to date most important outcome of such a shared patrimony is a set of electronic self-evaluation tests (EChemTest) [5] in chemistry and related support material meant to enhance knowledge and skills in chemistry. EChemTest covers the European Core Chemistry topics at three different levels, corresponding to the end of compulsory studies and the beginning of university studies and the completion of the core chemistry syllabus in analytical, biological, inorganic, organic, and physical chemistry. Moreover, tests are provided for synthetic and computational chemistry and specialized question banks have been created for chemistry applied in cultural heritage preservation. EChemTest contents are based on a syllabus developed by analysing the major European educational system and related teaching program contents.

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ADDRESSING LINGUISTIC ISSUES IN EUROPEAN CHEMISTRY EDUCATION

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The initiative is trying to meet the challenge of teaching chemistry in the multi-lingual European environment, by creating receptive communication skills at B2 level, with particular emphasis on strategies to be applied for understanding scientific articles and text books, for dealing with lecture situations, or for understanding spoken explanations of processes and installations.

In this context, Language for Specific Purposes Centres are implemented for at least the major European languages. They are dedicated in the development of teaching and testing material for supporting chemistry/chemical engineering education in multi-lingual environments.

The Centres are based on a hybrid learning environment, combining face-to-face instruction to a full coverage of all learning possibilities in on-line form.

Their responsibilities encompass:

- Development of material for teaching English to science-oriented trainees and students.
- Translation from English of already assessed on-line products dealing with chemistry and chemical engineering education at all levels.

For the time being, a manual on Teaching Languages for Chemists has being authored, addressing one-to-one or group training at B2 level. In addition, EChemTest is operational in French, German, Greek, Italian, Polish, Spanish, French, Slovenian.

The Centres are assisted by several projects in the frame of the Lifelong Learning Programme, namely English for Specific Purposes: Chemistry; English for Specific Purposes: Conservation Science; Chemical Engineering Studies: Developing Skills in English; - Testing English for Specific Purposes in Science; Valorisation of EChemTest Testing Centres; Joint Interface Third-Cycle Degrees in Chemistry; Development of material for teaching English to science-oriented trainees and students.

THE EUROLECTURER AWARD TO RECOGNISE UNIVERSITY CHEMISTRY TEACHING STAFF IN EUROPE

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The European Chemistry Thematic Network (ECTN) ran two successful summer schools for Newly Appointed University Chemistry Teaching Staff. These brought together fifty staff from around 25 European countries to explore aspects of teaching and to develop cooperation between the delegates.

In the subsequent European Chemistry and Chemical Engineering Education Network (EC2E2N) we have sought to build on this earlier experience by developing a framework which recognises those who have developed their skills in teaching chemistry at university level within a European context. It is hoped that such an award will increase the mobility of lecturers and promote the development of high level teaching skills across Europe.

It was established that such a framework should be independent of any recognition schemes already running within countries, and accessible to those from any country regardless of whether such schemes were available to them or not. The baseline for entry to the programme is thus to be suitable qualified to teach chemistry at the university level within that country.

Participants are paired and placed under the guidance of a mentor, such that all three members of each group are from different countries. Ideally, each group will also contain representatives of a diverse group of countries. The pair then undertakes discussion of an innovation that each member has implemented, or a comparison of the curricula within the two countries. They then collaborate to develop a resource or innovation that can be used in each country. This is then disseminated by one or more of a number of channels, but often through giving a presentation at the EC2E2N plenary meeting.

The first candidates will be completing their work this year, and strategies for sustaining the programme will be outlined. The possibility of including staff from outside Europe will also be explored.

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TRANSPARENCY FOR HIGH EDUCATION CURRICULA IN CHEMISTRY AND CHEMICAL ENGINEERING: A CHALLENGE!

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Let's imagine that you are a student in chemistry or chemical engineering, in the first or second cycle (let's look a few years back?...). You are enthusiastic and you have built a career plan, little by little. You find out you want to be a specialist in process control (why not?!), and also that you would love to go abroad, practice a foreign language, discover a new culture and open your horizons… You decide to attend a European institution (for 1 or 2 semesters), where process control is a domain of excellence. But how can you choose one institution amongst many others?!... How will you compare the curricula and the different degrees?
Of course your professors are there to advise you. However, they can not have a full knowledge of all the available opportunities. A general tool for transparent curricula description is needed.

Via the 10^{th} work package of the EC_2E_2N network, called 'Transparency', a group of 11 academics from 6 European countries - including chemists and chemical engineers, men and women – have added their forces to define a European curriculum database in chemistry and chemical engineering.

This database is to be filled with useful information about each existing curriculum: country and city, institution, degrees delivered, number of semesters, ects distribution, pre-requisite knowledge, person to contact and web site. To reach a large number of available curricula, the 'Transparency' working group has found first support through the member institutions of the EC_2E_2N, of the Chem*E*Pass project (ended in 2012), and through the international relations office of their institutions.

The database is already available on the Web[1], for students' use and academics' disposal, and will be presented. The success of Transparency will depend on the forces put towards it! Any European university involved in Chemistry and/or Chemical Engineering is welcome to submit the description of educational programs at Bachelor or Master level.

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STUDENT-CENTRED ACTIVITIES PROMOTING EUROPEAN SCIENTIFIC CITIZENSHIP: SUMMER SCHOOLS AND CONTESTS

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Intensive Schools in Conservation Science

The Intensive Schools on Conservation Science are dealing with the physicochemical aspects of cultural heritage preservation, and mainly addressed to 2nd and 3rd cycle science students, as well as active professionals, wishing to acquire a solid knowledge on the ways natural and material sciences are applied in the safeguarding and authentication of tangible works of art.

A multinational team of experts from Erasmus and Tempus countries are delivering theoretical and hands-on lectures on important aspects of conservation science, covering both basic information and research case studies. The practical courses dealt with both simulation of ancient methodologies and acquaintance with modern instrumental analytical techniques, including laser field exercises. All lectures were held in English.

Intensive Schools on Conservation Science has been carried out in Teruel (Aragon, Spain). The previous editions were held, Ist in Thessaloniki (Greece, 2007), 2nd in Palermo (Italy, 2008), 3rd inThessaloniki (Greece, 2009), 4th in Teruel (Spain, 2010) and 5th in Istanbul (Turky, 2011).

The Schools were attended as average by 50 students (from 11-13 European and Tempus countries) selected out of 150 applicants.

The 1st Summer School on Conservation and Restoration of Metallic Materials was held in Genova, Italy, on September 2-8th 2011 and focused on:

- introduction to metallic materials, considering the history of the artefacts and the importance of their conservation to our cultural heritage;
- overview on techniques used to investigate metallic materials with discussions and practical experiments in the laboratory;
- special sessions in "the field" using portable equipment (e.g. Metallographic replica, XRF, XRD) to characterize metallic materials.

Some numbers:17 Lecturers from 6 Countries, 50 hours distributed on 6 days, 24 Students selected from 45 submissions from 12 European Countries, 5 Case studies used as evaluation tests for students.

Student Contests

The project involved a two-step contest (first national then multinational) to award the best students and young chemists producing an original product (written story, power point, video, strip cartoons, poster, etc..) presenting to different audiences (to primary, middle schools, high schools, university students and to the general public) the solutions that chemistry is able to provide to free choice sectors of modern society (energy, food, health, water, transport, new technologies, etc.).

Competition among students was open to students of Chemistry, Industrial Chemistry and Chemical Engineering I, II, III cycle and high school students. The participating countries were: Austria, France, Greece, Italy, Poland, and Spain.

The original products posted to a web page prepared by the University of Salonicco (Greece) for all the participating countries except Poland having an own personal web site where the voting was made. Each country awarded the 6 most voted works and selected 3 artworks for the multinational step. The 14 national finalists received 588 votes. The authors of the 3 top rated work (one author to award-winning work) will receive a diploma and will be invited to attend the EC2E2N General Assembly and their expenses totally charged to the EC2E2N.

THE ATTRACTIVENESS OF CHEMISTRY AND CHEMICAL ENGINEERING

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The general objective of EC2E2N Work Package 14 was to verify the possibility of assessing the effectiveness of activities aimed at improving the public perception of Chemistry and Chemical Engineering. The workplan was:

1. collect information on existing activities
2. design assessment tools
3. implement and test prototype activities

In 2010 a web site has been set up in order to gather information on activities throughout Europe. Results (about 150 entries) have been organized according to type, effort required in the preparation, number of people involved and other categories. It was also asked whether activities were evaluated for effectiveness (short and long range). Based on these results, two short questionnaires were developed, one for students and/or general public and the other for teachers and/or experts.

This first draft of the questionnaire was tested in several activities in different countries. It became immediately clear that the answers only marginally addressed the point that was at the center of the investigation and they were different for the students and the teachers. Even among the workgroup members there were very intense discussions about the possibility of actually determining the effectiveness of public activities centered on Chemistry, particularly if this is done independently of context. One particular point was generally accepted: regardless of type of dissemination activity, "some" aspect of Chemistry should be better understood as a result. With this in mind, a second version of the questionnaire was set up.

In order to stimulate discussion, rather than examining in detail the results, the presentation, will focus on the above conclusion.

THE ESTABLISH PROJECT – WORKSHOP FOR TEACHERS IN CHEMISTRY INQUIRY

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Inquiry-based science education (IBSE) is an organized and intentional effort on behalf of a teacher to engage students in inquiry-based learning of science. The goal of inquiry teaching is not solely to transfer scientific knowledge, facts, definitions, and concepts, but rather to enhance students' ability to reason as they become independent learners, capable of identifying main questions and finding relevant answers to support their understanding. This results in a gradual but deeper acquisition and expansion of scientific knowledge and competences that are meaningful to the student. This student-centered approach to science learning incorporates a range of inquiry activities whereby the balance between teacher guidance and student independence can be adjusted to suit the needs of the classroom.

This workshop will show and demonstrate the approach adopted by consortium members of the FP7 ESTABLISH project, to address the challenges and approaches of implementing IBSE on a wide scale across Europe, whereby a series of units have been developed that support teachers in implementing IBSE in their own classrooms. The topics for the units were selected so that they were interesting to the students, and yet relevant to the curricula of each country. In addition to addressing core concepts in science, each unit includes industrial content knowledge to incorporate authentic learning experiences from the scientific and industrial communities in teaching the selected topic.

A series of units for chemistry education have been developed for use in teacher education and for teachers to use in their classrooms. In this workshop, participants will have an opportunity to explore one of the units – *Exploring Holes*. In this unit, material is divided into 3 levels, loosely aimed at lower, middle and upper second level chemistry by focusing on phenomena, simple models and the interaction of phenomena and more sophisticated models.

"Holes" to be explored can be found in many different contexts, such as diapers, dialysis or to get rid of unpleasant odors. Participants will not only get the material but can also carry out some of the hands-on activities made for the students. Ideas for assessment of inquiry learning will also be presented.

INTEGRATING WEBQUEST INTO CHEMISTRY CLASSROOM TEACHING TO PROMOTE STUDENTS' CRITICAL THINKING

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The WebQuest is a student-centered, inquiry-oriented and project-based approach for teaching and learning that students use Web resources to learn school topics. This article reports on the design, implementation and evaluation of a WebQuest teaching approach for chemistry classroom teaching in improving the critical thinking of high school students. A pre- and post-test design was used where 4-month long-term WebQuest teaching approach with five chemical topics was offered to 50 high school students aged ranged from 16 to 17 years in Xi'dian Middle School attached to Xidian University in Shaanxi province of China. The California Critical Thinking Disposition Inventory (CCTDI) and the California Critical Thinking Skills Test (CCTST) were employed as data collection tools. Both CCTDI and CCTST scores of the participants showed significant differences ($p < 0.05$) between before and after WebQuest learning. The subscale scores of CCTDI showed significant differences in all aspects of dispositions toward critical thinking except open-mindedness and maturity. For CCTST subscales, the scores showed significant differences in analysis and evaluation but in inference.

These findings add to the evidence that integrating Webquest into science classroom teaching might be an effective way to develop high school's students' critical thinking.

Keywords: Web-based learning, Critical thinking, Computer-based learning, WebQuest, Chemistry classroom teaching

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RELATIONSHIP BETWEEN STUDENTS' CHEMISTRY ANXIETY AND THEIR PERFORMANCE IN STOICHIOMETRY

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Stoichiometry is regarded as one of the fundamental "tools in the chemistry toolbox" (Evans *et al*., 2006) and the success with it involves one's ability to carry out multistep abstract algebraic exercises accurately (Evans *et al*., 2008). Although students may successfully answer numerical questions addressing these stoichiometric problems, many struggle to master important concept such as the mole and number of particles. Students tend to treat stoichiometric computations like any other problem in mathematics with little display of their knowledge of the chemical concepts involved. Difficulty in understanding microscopic world of chemistry might be one of the contributing factors as this level is the most challenging for students to master (Chittleborough & Treagust, 2007) because it cannot be seen and touch, thereby making it abstract to students. The purpose of the study was to determine whether chemistry anxieties existed among Tunku Abdul Rahman College (TARC) Diploma (first year) of Chemistry & Biology and Diploma (first year) of Food Science students and whether chemistry anxieties were correlated with achievement in stoichiometry. Fifty five diploma (first year) in chemistry & biology students and thirty one diploma (first year) food science participated in the study. Derived Chemistry Anxiety Rating Scale (DCARS) developed by Eddy (1996) was used to measure chemistry anxieties and students' achievement in stoichiometry was measured using semester end examination (stoichiometry components). The results of the study show that first year diploma students (chemistry & biology and food science) were feeling anxious about stoichiometry and there was a significant correlation between chemistry anxieties and achievement in stoichiometry. Implications of findings to reduce anxieties for effective learning in stoichiometry were suggested.

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AFRICAN STUDENTS' (GRADE 12) DIFFICULTIES IN LEARNING THE SEMIOTIC REPRESENTATIONS OF THE SPATIAL STRUCTURE OF ORGANIC MOLECULES

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This study aims at identifying and analysing the learning difficulties of beginners regarding the semiotic representations of the spatial structure of organic molecules from a visualization perspective. The three-dimensional arrangements of atoms in molecules are depicted by two-dimensional drawings such as Cram representations (solid wedged and hashed wedged bonds) or Newman projections which constitute two different semiotic systems[1]. Each semiotic system conveys its rules, conventions and symbols giving rise to semiotic representations of molecules. Treatment and conversion of semiotic representations need visuospatial abilities[2,3] such as mental rotation[4] or iconic visualization[5]. A questionnaire was designed to determine to what extent grade 12 students in Benin (Africa) master the transformations of the semiotic representations of organic molecules. A paper-and-pencil test including four questions was administered to 340 students aged 17 to 20. The analysis of the answers revealed that a great proportion of students does not master the treatments of the Cram's semiotic representations. No student can draw a correct staggered conformation from an eclipsed conformation (the task requires a mental rotation of an eclipsed conformation). One third cannot identify pairs of conformational isomers out of a list of six conformations (the task involves an iconic visualization i.e. recognizing a typical shape and identifying the object[5]): they recognized the shape of the representations –staggered or eclipsed– but without paying attention to the place of the different atoms bonded to the carbon atoms. The most difficult task seems to be the conversion of a Cram representation to a Newman projection. The students had to determine if a Newman projection in a list of three could have been drawn looking mentally at the right or the left of a Cram representation or not, three Cram representations were proposed. No student gave a totally correct answer. More than a third did not answer. The analysis of numerous incorrect answers revealed that most students cannot manipulate proper mental images or even generate them.

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DEVELOPMENT OF A COOPERATIVE LEARNING MATERIAL ON HIGH SCHOOL CHEMISTRY TEACHING "SPONTANEITY"*

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Researches have shown that students have many misconceptions about chemistry subjects[1]. The misconceptions are the most important factor which reduces students' learning achievement. Therefore development of active learning materials, which ensure the effective construction of knowledge, and prevent the formation of misconceptions, has come into prominence[2].

This study aimed to develop an active learning material related cooperative learning based on constructivism about the subject of *Spontaneity*, in the curriculum of high school chemistry, by considering misconceptions determined in the context of literature review. For this purpose, the basic concepts related to the subject were correlated with the sub-concepts underlying for meaningful learning of the subject. The validity of the material was tested by comments of experts. In the context of the study which quasi experimental design with pre-test, post-test control group was applied, the reliability of the material was determined by participation of fifty-two students from two different classes which were randomly assigned to experimental and control groups. Before the instruction, the Readiness Test was applied to all students. The results reflected no significantly differences between experimental and control groups ($p>0.05$). The instructions of *Spontaneity* were accomplished with the active learning material in the experimental group and with the existing teacher-centered curriculum in the control group. After studies which were carried out simultaneously in both groups, in order to determine students' learning achievement about the *Spontaneity*, the Achievement Test was applied on both groups. The results showed that the experimental group significantly had higher scores ($p<0.05$), and fewer misconceptions than control group.

In conclusion, the obtained results from this study showed that the new active learning material based on cooperative learning was effective on increasing students' learning achievement, preventing misconception. For this reason, it is crucial to develop, apply and generalize active learning materials based on constructivism in whole chemistry curriculum.

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HOW DO PRE-SERVICE CHEMISTRY TEACHERS CONNECT SOLUBILITY OF GASES IN LIQUIDS TO DAILY LIFE EVENTS?

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Chemistry should be taught by emphasizing its necessity for industry, technology, society, and everyday life in order to educate scientifically literate citizens[1, 2]. The relationship between the macroscopic, symbolic, and microscopic levels of chemistry and real-life should also be established during instruction in order for students to understand chemistry concepts meaningfully[3]. To make chemistry relevant for students, teachers' knowledge about the relevance of chemistry concepts to daily life is important. However, there are few studies which examined the knowledge of teachers about the relationship between daily life and chemistry concepts[4]. The aim of this study was to investigate how pre-service chemistry teachers relate the solubility of gases in liquids to daily life. Eleven pre-service chemistry teachers participated in the study. Utilizing qualitative research design, data were obtained through an open-ended question and then, semi-structured interviews were conducted with five participants in order to get deeper information. Participants were asked to give daily life examples for the effects of temperature and pressure on the solubility of gases in liquids and explain their reasons. For data analysis, their daily life examples and explanations were examined and categories were formed. Analysis of the data indicated that some of the participants stated the effect of temperature and pressure on the solubility of gases in liquids incorrectly. In addition, some of them did not give a correct daily life example although they knew how the temperature and pressure affect the solubility of gases in liquids. The majority of the participants did not attempt to explain the topic at microscopic level. Even for the ones who tried to explain the topic at microscopic level, some explained the concepts incorrectly and hold misconceptions. As a result, pre-service teachers had difficulty in integrating chemistry concepts into real life situations and emphasizing levels of chemistry. Therefore, these issues should be taken into consideration by science educators in both universities and schools in order to improve meaningful learning.

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USING THE WEB-BASED MENTAL MODEL DIAGNOSTIC (WMMD) SYSTEM TO ANALYZE JUNIOR HIGH SCHOOL STUDENTS' MENTAL MODELS OF GAS PARTICLES

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It has been a challenge for students to learn science concepts in school and also a challenge for teachers to understand what, how and why the students have difficulty to construct their knowledge of scientific phenomena both in macroscopic and microscopic perspective. The purpose of this study was to use a Web-based Mental Model Diagnostic (WMMD) system to diagnose students' mental models of the behavior of gas particles and to understand if students used a consistent model to explain the behavior of gas particles across a series of test items. Three hundred and two students, including 97 seventh, 104 eighth, and 101 ninth grade students participate the study. The test items were designed based upon Treagust (1995)'s method of two -tier test items. The first tier of each item emphasized the judgments of a macroscopic phenomenon as opposed to the second tier that required microscopic reasons for explaining the macroscopic phenomenon in the first tier. Expert validity was carried out by two university professors with science education and chemistry background. Also, the instrument was piloted and the internal reliability alpha was found to be .893. The results revealed that among the 159 students possess randomization of particles behavior, 109 students (36%; namely 7th: 9%, 8th:11%, and 9th: 16% respectively) thought that air movement was continuous, while 35 students (about 11.59%, namely, 7th: 4.64%, 8th: 4.64%, and 9th: 2.31% respectively) still thought that half gas particles are static and the other are continuous movement. Finally, only 1% junior high students has Scientific Model. In sum, from seventh through ninth grade, students' inclusion of submicroscopic representations in models of gas particles continually increased. Despite this development, most students at the junior high level did not yet possess accurate scientific mental models of gas particles. The findings of this research suggested that the WMMD system were able to allocate each individual responses to a set of questions that related to gas particles by the large amount of data from our participants. The system also offers advantages including flexibility of selecting test items for diagnosing students' mental models in a complex system of knowledge, the ability to collect large amounts of data, and adopting it into school instruction and assessment. Other educational implications will be discussed.

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EFFECTS OF MODELING AND MULTI-REPRESENTATIONAL MODELS APPROACHES ON ELEVENTH GRADE STUDENTS' LEARNING OF MOLECULAR STRUCTURES

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Background: In the past twenty years, there have been a number of reforms in science education, and throughout these changes the value of models and modeling and models in students' learning of science has repeatedly been confirmed (AAAS, 1993; NSC, 1996). Building on this research base, the current study was intended to guide students to learn **molecular structures** concepts by means of modeling processes—*model selection, model construction, model validation, model analysis, and model deployment* (Chiu & Chung, 2010; Halloun, 1996)—with the use of multi-representational models approaches (e.g., *visual models*, *concrete models*, *gestural models, mathematical models*, and *verbal models*).

Purpose: This research aimed to improve our understanding regarding students' conceptual change as they are taught about molecular structures. Three assessments (before, during, and following instruction) were implemented.

Participants: 71 eleventh graders, ages 16 to 17, mostly from high socioeconomic status families, in a national senior high school in Taipei County, participated in this study. Their academic performances were at the medium level among all senior high school students in Taiwan.

Research Design: The research adopted a quasi-experimental design to study two groups of eleventh graders: (1) the modeling and multi-representational models group (MM; 20 males and 16 females); and (2) the modeling and general 3D molecular models group (M; 27 males and 8 females). Both groups used the same textbooks and were engaged in ten courses (each lasting for 50 minutes) of instruction. Prior to formal teaching, students in both groups were administered the same pretest. The second test was implemented after five courses (halfway through instruction), and the posttest given after ten courses (at the completion of instruction).

Instrument: A series of test items was administered to all of the students in both groups. The topics tested covered students' views of molecular structure including covalent bonding, σ and π bonding, molecular shapes, molecular structures, the same electronic principles and VSEPR theory. The test items were piloted with 80 twelfth graders who had already learned the related concepts of molecular structure (via conventional teaching). The reliability of the test was high (Cronbach alpha = 0.92).

Data Analysis: Comparing the MM group with the M group, the statistics showed that there was a significant difference between the two groups before teaching (independent-t test, $t(70)$=0.062, MM=M). Thus, the significant differences found for both groups for the remaining assessments used the pretest as covariance to conduct an ANCOVA test. ANCOVA results revealed that there were significant differences between the two groups in the during instruction test ($F(2,69)$=4.07, p<.05, MM>M) and posttest ($F(2,69)$=17.71, p<.001, MM>M).

Conclusions: Our findings indicate that using multiple modeling approaches for teaching should be encouraged for meaningful learning of concepts related to molecular structures for secondary students. The learning effects of each modeling component during the modeling process still leave room for further analysis. The research results support the assertion that model-based learning experiences are helpful to the learning of scientific concepts and enable students to learn how to systematically perceive such concepts and revise their misconceptions.

Key words: modeling process, modeling, multi-representational models

Selective Reference

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TEACHING AND LEARNING SCIENCE AND CHEMISTRY IN SOME LATIN AMERICAN, EUROPEAN AND ASIAN COUNTRIES

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The quality of physical, mathematical, chemical and biological education is a key factor of development of science and technology of any country. The 20th and 21st centuries showed us different examples of countries who reached their high level of development due to constant attention and efforts to raise the level of scientific instruction: Korea, China, Finland, USSR and others. The significant results of science and technology in the BRICS union of countries in last decades can be explained too, taking into account the constant attention of the national authorities in these issues. These examples are important for all other countries who plan to improve their level of development, especially in the Latin American region (Risch 2010).

It is known that Chemistry represents the most difficult subject for students of secondary, high and highest schools because of a big number of abstract concepts and theories in its curriculum. For this reason there is an important interest of researchers of science education to different aspects of chemical methodology (Orlik 2002).

It is known too that "some countries seem to provide more effective education than others. The students in those schools do better on tests, are more likely to finish high school, and are more likely to seek higher education" (Canroy 2007). There are some countries in the world that have interesting results in science and math education too (Risch 2010). For example, in Latin America, Cuba represents a particularly interesting phenomenon in testing students' knowledge in science and math that is higher than in other countries in this region (Canroy 2007, Orlik 2007, Torrecilla, 2006).

Another interesting educational phenomenon is found in countries of Eastern Europe that now develop their own and particular educational systems. These have been especially successful in the field of science and math education (Orlik 2002). There are some important scientific and educational links between the Cuban and Latin American educational systems and the former Eastern European educational system, that should be understood deeply.

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CHEMICAL EDUCATION IN POLAND: PAST, PRESENT AND FUTURE

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Chemistry was first introduced as a school subject in Poland at the turn of the nineteenth century. A figure who had a considerable impact on the development of chemistry teaching in the second and third decade of the previous century was Jan Harabaszewski, whose name is on the medal for outstanding achievements in the field of chemical education awarded by the Polish Chemical Society.

The Polish educational system consists of primary schools (6 years), junior secondary schools (3 years) and senior secondary schools (3 years). Pupils start learning elements of chemical knowledge as part of a subject called "science" in grades four to six of elementary school. In junior secondary schools, chemistry is taught as a separate subject and the pupils need to complete 4 hours per week over a period of three years. Starting September 2012, as a result of a reform of the education system, only one hour of chemistry will be compulsory in the first grade of senior secondary school.

Chemistry and physics are the least popular science subjects among pupils. This is confirmed by surveys conducted among pupils and by the number of pupils who choose these subjects as obligatory or additional for the Matura exam. The scores achieved by Polish pupils in the scientific literacy part of last PISA surveys in 2009 are slightly higher than the average scores for all countries participating in it.

Teachers have the greatest impact on the effectiveness of chemical education. The teaching profession, however, is not highly appreciated by students of chemistry, who can choose to qualify as teachers. The system of teacher education and training is constantly changing. In the course of their career, teachers − after meeting the necessary requirements − can get four successive promotions in rank. Teachers of chemistry can make use of a journal devoted to teaching chemistry problems ("Chemistry at school") which appears five times a year.

It is alarming that it is increasingly rare for pupils to be able to observe and carry out chemical experiments. Undoubtedly, it is a great challenge for teachers to reconcile the interests of students who need chemistry knowledge mainly in everyday life with those of students who have to acquire deeper knowledge in order to undertake university studies.

Chemistry educators conduct research into chemistry teaching, help teachers develop and improve their teaching skills, develop materials for teaching chemistry, including textbooks, participate in international programmes which support chemical education and cooperate with chemistry teachers on a wide range of issues.

CHEMISTRY AND SCIENCE EDUCATION IN THE SLOVAKIA

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This article presents the development of chemistry and science education at primary and secondary schools in Slovakia from the 1990s up to present time.

A cohesive system of education was in Slovakia from 1946 to 1989. It was represented by state regulation and state curricula. On 1st September 2008 national school reform, with new state and school curricula, was started in Slovakia. We accept the International Standard Classification of Education for the elementary school ISCED 1, the lower secondary school ISCED 2 and the upper secondary school ISCED 3.

The students familiarize with chemistry and science in the subjects "Natural Science" which are taught at the elementary school (1^{st}-4^{th} grade, age 6-9, ISCED1). The curriculum contains 7 integrated themes and chemistry is the part of the theme "Nature and Society"

The teaching of chemistry and science subjects at the lower secondary school (5^{th}-9^{th} grade; age 10-15, ISCED2) is continuous with the theme "People and Nature" which incorporates 3 subjects chemistry, biology and physics. At the upper secondary schools (10^{th}-13^{th} grade; age 16-19, ISCED3) chemistry teaching is a separate subject (10^{th} grade – 2 hours, 11^{th} grade – 2 hours, 12^{th} grade – 1 hour), or high school (5^{th}-12^{th} grade, age 10-18, ISCED3)

The school reform creates the more independent environment for schools at the national and regional level. The state curricula of chemistry present 60% of necessary knowledge and competence and schools can create 40% optional school curricula, which represents the interests of students, regional particularity, specification of school etc.

Since 1^{st} September 2011 the framework curricula for primary schools and secondary schools are validated. Curricula contain information on the minimum time granted for individual subjects for all grade education. It has also removed the layout of the curriculum of individual subjects in grades. Distribution of hours of educational content and layout of the grades is the responsibility of the principal and teachers of the school.

The modern school of the 21^{st} Century needs complex reform – content, methods, technologies. Since 2009 we have started the National program of Modernization of education at primary and secondary school in Slovakia. We are retraining the 600 chemistry teachers (total 7000 teachers) for education orientated to the student, with support of digital content and technologies.

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CHEMICAL EDUCATION IN RUSSIA: FEATURES AND TRENDS

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What are the *similarities and differences* in methodology, theory and practice of modern chemical education in some countries in Latin America, Europe and Asia? The answer to this question can be complex, setting, above all, *the characteristics* and *trends in* modern chemical education in these countries.

Students in Russia are studying Chemistry in primary and secondary school, as well as in various higher educational institutions. Therefore, the current Russian Chemical Education is a complex *integrative object that* has certain stages, levels, and constituents.

There are important specifics of Russian chemical education: 1) the *integrative character,* because it consists of different parts; 2) *the multilevel* nature of its new goals and challenges posed by the socio-economic, scientific, technological and other changes taking place in a multicultural, multi-ethnic, multi-confessional Russia; 3) *the openness of* its structure and content, due to new directions, levels, profiles, specialties and different innovations; 4) the structural *integrity* in operation of interrelated components; 5) *the complexity of* its various aspects (educational, psychological, didactic, technological and other); 6) the *adaptation* of it to the requirements of the state, society's expectations, and the needs of the individual; 7) the different *orientation* (cultural, spiritual, moral, profile, professional, axiological, competence, environmental, etc.) implemented in the present, based on past experience, but focused on the future.

The above-mentioned features of the modern Russian chemical education show *trends of its further development,* which should include the following:

1) providing *a new quality of* education (the formation of universal educational activities, different competencies, value relations);
2) the implementation of the philosophy *of value meanings* of education;
3) the application of the *paradigm of innovative* education;
4) the introduction of *individually oriented models of* education;
5) *humanitarian updates* and education through the integration of science and humanities approaches;
6) the use *of integrative methodology in the educational process;*
7) focusing on *integrative and contextual concepts* of chemical education.

CHEMISTRY AND SCIENCE EDUCATION IN THE CZECH REPUBLIC

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This presentation informs on the development of chemistry and science education at primary and secondary schools in the Czech Republic from the 1980s up to present time.

The students encounter the first elements of chemistry and science in the subjects "First learning" and "Natural Science" (in translation) which are taught at the elementary school (1^{st}-5^{th} grade, age 6-10). The students should learn to describe known natural and artificial substances, as well as to plan, to perform and to explain a simple experiment. The teaching of chemistry and science subjects at the second stage of primary school (6^{th}-9^{th} grade; age 11-15) and at secondary schools (1^{st}-4^{th} grade; age 15-19) is realized through separate independent subjects.

A reform of primary and secondary education was realized in our country during the 1980s. The organization, but mainly the contents, of education were changed. The general terms, principles and theories used for deriving the specific phenomena became the base of the education in science subjects – chemistry, biology and physics. Though there has been a number of changes have been carried out in our educational system during recent years, the conception of the teaching of these subjects – introduced at the beginning of the 1980s – has not changed significantly and created a framework for the teaching of science subjects up to the beginning of the 21st century. The main problem of this conception, in the first instance, was a gradual concentration on a great number of concepts that were referred to in the curricula, and mainly in secondary school textbooks, without devoting time and space to a sufficient acquisition of the concepts concerned. Moreover, these concepts are mainly referred to only theoretically, and often there is a complete lack of space enabling us any practical verification. Another problem is a mutual isolation of the teaching of the individual subjects. The framework educational programs (2005-2007) should gradually reflect the main changes in the teaching of science subjects – a reduction of learning material, a greater emphasis on the competences, application and problem solving; observations and experiments, and communication, along with a greater mutual interconnection of the materials learnt.

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LEARNING CHEMISTRY WHILE CREATING SIMULATIONS: A BRAZILIAN EXPERIENCE

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Since 2000 some Latin-American countries such as Peru, Venezuela, Argentina and Brazil have started to develop technology for specific pedagogic use, through the Secretaries of Education of all of these countries. In particular, in Brazil this work was introduced through governmental departments involving both high school, technical and distance Education and the project was called RIVED – Interactive Virtual Network for Education. Professional experts developed learning objects in the area of Chemistry, Biology, Physics and Mathematics specifically for high school students. These simulations would be the basis for the Virtual Fabric that was developed through the production of hundreds of simulations in different Universities, all of them within a collaborative plan in which every productive group should have leading specialist professors both in science and didactics and instructional designers and programmers of technical areas. Pilot experiences were held in order to achieve in-service training with public school professors before introducing this scheme to the students. They learned how to write their own scripts based in some problem related to curricular science themes, in order to teach their students how to be authors and creators of their own simulations. The results of these experiences with around 40 chemistry teachers and their students, both showing their process and their products, and how they used the simulations they produced, shall be shown in the symposium.

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INTRODUCING REAL RESEARCH IN CHEMISTRY EDUCATION FOR YOUTH AND ADULTS

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Science education in Brazil encounters many difficulties and the fact students have low participation in scientific activities is one of the major problems. One of the solutions is the introduction of problem-based activities in formal curricula where students can develop all the different skills related to the use of scientific methodology. (1)

The goal of this research is to investigate methods that can introduce students of different public school levels, to have a new and better insight towards science and especially towards chemistry, using theme research projects such as *Ecology of Waters*, where they can analyze physicochemical parameters of nearby rivers and lakes. As they research real problems of their own communities, collecting their own data, working in groups, and exchanging their results between themselves and with students from other schools, they have a clear image of how senior research should be carried out. They might also have a clear notion of the environmental problems in their community and eventually submit proposals to local governments. Finally they might become interested in knowing more aspects of scientific life and try to develop future researches during their next school levels.(2)

Some pertinent characteristics of qualitative investigations were considered in this research (3). Interview transcripts and written questionnaires for teachers and students were used as primary sources of data. As secondary sources, meeting memos of the laboratory group, exchanged e-mails, handbooks produced for the teachers, reports from teacher training sessions, laboratory reports, and videos of the outside research activities were used.

Our aim in this presentation is to show how the introduction of such investigative issues involving authentic research in special educational levels with adult students that left their K12 education in some moment of their life, motivates and enhances significant learning in them, showing how this enthusiasm also generates pleasure in attending their chemistry class. It also shows them the importance of chemical analysis quantification in order to validate all their research assumptions.

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CHARACTERIZATION OF HIGH SCHOOL CHEMISTRY IN BRAZIL

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There is no doubt about the importance of chemistry in current technological society. As the central science in technological processes its level of development is a fundamental sign of the country's position in economic relations. At the same time, and paradoxically, the study of chemistry by the new generations of young people has increasingly become diminished of meanings[1]. The causes of this lack of interest are varied, with complex interactions which are impossible to be solved by simplistic approaches. In Brazil, the failures of chemistry teaching indicated by numerous researchers[2 3 4] are varied and range from the lack of own goals, within the inadequate selection of content, the quality of instructional material, by implicit and explicit views on science during the education processes, to issues related to teacher formation, both in relation to the quality of educational aspects in initial training courses and in relation to the necessary quantitative needs demanded by the country. In addition to the mentioned problems there is, in Brazil, a community of researchers in Chemical Education that have been coming to strengthen, during nearly 40 years, this field of scientific research, besides the political commitment with a relevant chemistry teaching to the students and to the country. This community has created specific forums of socialization and validation of scientific production, producing quality instructional material, developing educational projects and publishing books and papers[5]. This work intends to analyse these specificities of high school's chemistry teaching in Brazil by the research of chemical educators who investigate the classroom educational processes with the intention to make a contribution to improve teaching in the country's educational public policy context.

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INQUIRY-BASED LEARNING IN JAPAN

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Challenges of inquiry-based instruction in Japan have so far been advocated by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) with the guidelines of the Courses of Study.[1] Though it is regrettable, systematic teaching methods are not established and actually there is almost no example of systematic instructions until now from primary schools through upper secondary schools by the reason of teachers' discretion. Of course, in the corresponding schools, inquiry-based instructions have been individually advanced by discretion, and appropriate success has been achieved. Recently, MEXT is enforcing Super Science High Schools (SSH) which focus their education on science and math putting practice of inquiry learning on importance, and the Japan Science and Technology Agency supports them. Selected SSH has amounted to 145 schools including 29 as the Core SSH in 2011 and is aimed at 200 schools by 2014.

In the university-level education, it is rare that systematic inquiry-based instruction is incorporated on a curriculum because of graduation research being done the last reaching point on a curriculum as compulsory subject at almost all Japanese universities. The graduation research is performed along with the process of science on the basis of inquiry-based approaches. Through the practice of the process, students raise the ability to design and conduct scientific investigations, formulate scientific explanations using experimental evidence, and effectively communicate the results of scientific investigations. Especially in natural science, it is considered that acquisition of knowledge and skill based on a framework of scientific system is very important, and adequate special-subjects have put weight on it as the preparatory step towards graduation research. This view has not been an exception even in a subject experimental. Recently, the trial which gazes at inquiry-based instruction has come to be seen with university's own discretion also as preparation of graduation research. In this session, the current situation and trials of inquiry-based instruction mainly on tertiary education in Japan (high school education is also within a view) are introduced.

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INTEGRATION OF INQUIRY-BASED TEACHING IN FINNISH CHEMISTRY CURRICULUMS

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Chemistry is an experimental science and laboratory experiments and different observations have an essential role when students are constructing their higher chemistry knowledge. Quite often laboratory experiments in schools are tried to execute in too short time slots and with very detailed lab-instructions. These too "receipt like" instructions do not encourage students to evolve their own thinking and problem solving skills. To promote the high order thinking of student's teachers should offer more open research projects instead of ready-made lab-instructions. One useful method is the inquiry-based teaching. By using inquiry-based methods students examine the chemical phenomena and concepts by generating their own research questions and experimental frameworks with help of teachers.

Finland is famous of high quality, well educated and appreciated teachers. In Finnish curriculums the general learning objectives are defined but teachers can freely choose teaching method they prefer. Finnish curriculums are reviewed to find out how inquiry-based teaching is integrated into the Finnish chemistry curriculums through all school levels. Also a concrete example of used method is introduced.

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FOSTERING SCIENTIFIC INQUIRY WITH WORKED EXAMPLES AND PROMPTS

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Scientific inquiry has been a part of the German science education standards for secondary schools since 2005, which require that students learn how to solve a problem scientifically[1]. To achieve this goal, a teaching unit for 6th grade students at German full-day secondary schools is developed and evaluated. To foster scientific inquiry, worked examples with integrated experiments and metacognitive prompts are used. Worked examples are exercises which contain a task (a problem, for example) and an elaborated solution. Worked examples are expected to reduce extraneous and increase germane load[2], since they guide students through their learning in adequately challenging steps. Additionally, metacognitive prompts are assumed to support students during their self-directed learning process[3] and, hence, learning outcome should increase. This intervention study follows a pre-, post-, follow up-design with three experimental groups. Students in experimental group 1 work with worked examples with integrated experiments and metacognitive prompts, students in group 2 learn with worked examples with integrated experiments only, while students in the control group (group 3) solve experimental problem solving tasks. The underlying assumption is that students in experimental group 1 achieve a higher learning outcome, than those in group 2. Those again should learn more than students from group 3. A pilot-study was conducted in three German secondary schools with 67 students at the end of 2011. First results show that in a structuring test, which measures students' knowledge in the experimentation process of finding an idea, designing an experiment and drawing a conclusion[cf. 4], students in experimental group 1 significantly gain knowledge ($t(22)=4{,}88$; $p<.001$). There are also significant learning increases for students in group 3 ($t(15)=3{,}75$; $p=.002$) and in group 2 ($t(21)=2{,}59$; $p=.017$). These first results show the potential of the developed teaching unit to foster students in the domain of scientific inquiry. Further analyses will show to what extent the treatment differences impact the learning outcomes between the three groups. The findings of further analyses can be presented at ECRICE 2012.

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INQUIRY-TYPE LABORATORY ACTIVITIES IN CHEMISTRY FOR HIGH ABILITY STUDENTS

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Avi Hofstein developed the Inquiry-type Experiments at the Weizmann Institute of Science, Israel. His method is made up of 2 phases: the Pre-inquiry Phase teaches students to make observations, while the Inquiry Phase allows students to ask relevant questions, formulate hypotheses, and conduct planned experiments to test their hypotheses.

At Raffles Institution, we work with high-ability boys (ages 15-16) and run a highly compacted curriculum. We adapted Hofstein's method when teaching the concepts of rate of reaction and the reactivity of metals. We will share how we modify Hofstein's method, the activities carried out, as well as the reflections of teachers and feedback from students.

IDENTIFYING STUDENT UNDERSTANDINGS OF MECHANISMS WITH POGIL TYPE ACTIVITIES

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It is recognised among teaching academics that students often have difficulties with organic chemistry mechanisms, particularly the symbolism used to describe the processes.[1,2,3] This study focused on a first year organic chemistry class and identified student misconceptions about the curved-arrow formalism and addition reactions. A POGIL (Process Orientated Guided Inquiry Learning, www.pogil.org) approach was used in the development of activities designed to investigate ways of addressing and correcting student misconceptions about these concepts. Results suggested that while some misconceptions were successfully addressed, others were persistent and difficult to correct. An understanding of what curved arrows represent was improved in students; however difficulties with appropriately drawing curved arrows to represent bond breaking and bond forming processes remained evident. Similar improvements were observed in student understanding of addition reaction mechanisms. Finally, a number of participating students were surveyed using an adaption of the Student Assessment of Learning Gains (SALG) model. The results of this survey indicated a general overall positive perception of group and team work and suggested that the devised activity was of much help in assisting students in their understandings of key concepts.

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INVESTIGATING THE IMPLEMENTATION OF INQUIRY-BASED CHEMISTRY EXPERIMENTS IN REGIONAL INDONESIA SECONDARY SCHOOLS

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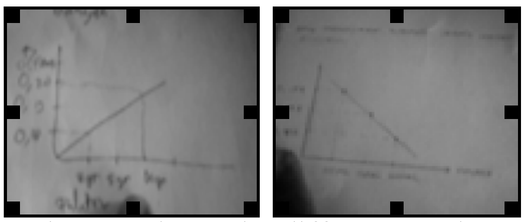
This study reports a project exploring the use of inquiry strategies in chemistry teaching in regional schools in Indonesia. It addresses questions about the feasibility of teachers implementing inquiry-based experiments in their classrooms. This study builds on the work of Thair and Treagust (1997) in which it was shown that inquiry can be implemented in Indonesian classrooms. However more than a decade later, a survey at the start of this project revealed little evidence of inquiry activities in regional settings and so the present study focused on working with teachers to develop their skills and confidence with inquiry.

Data was collected using qualitative methods including interviews and classroom observations during both the workshops and the implementation phases of the study. This paper will describe the resources especially developed for the project and the results of both the workshops with the teachers, and the mentored implementation of inquiry.



Azira's students plot different graphs to analyse their data.

The experience of two of the eight teachers involved will be described, guiding their Grade 10 students to design procedures, collect data, make explanations, and draw conclusions. Characteristically, they used different strategies that reflected their experience and teaching styles, and which led to different outcomes and products from the experiments. Azira, a senior and very experienced teacher, challenged her students to come up with ideas, while Hafrida, a less experienced teacher, was more willing to give assistances to students. Both teachers recognized major constraints that hamper the implementation of inquiry experiments in this setting; the large number of students, and the lack of time and resources. They commented on the importance of the knowledge and skills they had gained about inquiry during the workshops and mentored implementation.

The major conclusion of the study is that inquiry is feasible in countries such as Indonesia. But, support that gives teachers the experience of using inquiry successfully, despite the constraints, in the classroom is critical to success.

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EVALUATING THE SAQ SCHEME FOR ASSESSING MEANINGFUL UNDERSTANDING AND SYSTEMS THINKING IN THE ORGANIC CHEMISTRY DOMAIN

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The Systemic Approach to Teaching and Learning (SATL) teaching model has been developed during the past decade.[1,2] The Systemic Assessment Questions (SAQs) are assessment tools proposed in the SATL model, aiming to a more effective evaluation of the systemic oriented objectives.[3] Recently, fill-in-the blank SAQs were developed and evaluated for assessing students' meaningful understanding of organic reactions.[4] Now, the SAQ scheme has been further developed and evaluated for capturing systems thinking in the organic chemistry domain. Based on an assessment development model,[5] a systems thinking construct was defined, SAQ items that are aligned with this construct were developed, and a scoring rubric that reflects adequate levels of systems thinking skills was described. Moreover, various types of objective items were developed and evaluated regarding their effectiveness on assessing meaningful understanding of organic chemistry concepts. The relationship between students' responses on the SAQ and the objective item assessment schemes was also explored. The results indicated that the SAQ scheme can elicit systems thinking skills, on the basis of a formalistic systems thinking theoretical approach.[6] The psychometric soundness of this assessment scheme has also been established. Moreover, it was found that properly designed objective items can effectively capture aspects of meaningful understanding in the organic chemistry domain. Finally, a significant interrelationship was observed between students' responses on the two applied assessment schemes. The results provide evidence that the development of systems thinking is related with the enhancement of meaningful understanding of science concepts.

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THE CHEMISTS' TRIANGLE AND A GENERAL SYSTEMIC APPROACH TO TEACHING AND LEARNING CHEMISTRY

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Most chemistry educators acknowledge that there are macro-, micro- and symbolic aspects of all chemical concepts. However there are many who have yet to develop a general approach to teaching and learning that takes account of these. To give one example, chemical reactions may be described, represented by symbolic equations, and interpreted microscopically, but on separate occasions and in ways that provide minimal overlap and synergy.

Previously we have advocated the chemists' triangle as a framework for development. We proposed convenient and cost-effective tools (microscale experiments, 2-D and 3-D molecular modeling) for linking the three corners of the triangle whatever the chemical concept might be. We now propose this triangle be embedded as a core organizer within a systemic approach to teaching general chemical concepts. The triangle may be seen as one of the most basic systemic diagrams, from which more complex ones can be developed.

In our elaboration of this proposal we use the points of the triangle as starting points for developing concept maps reflecting the macro-, micro, and symbolic aspects of the chosen concept (e.g. pure substances, chemical change). Sub-concepts within each of these concept maps are then cross-linked with ones in the others, creating circles of linked sub-concepts around the triangle.

STUDENTS' PERCEPTION OF MATTER AND ENERGY CONSERVATION IN CHEMICAL REACTIONS

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Neither matter nor energy is conserved in chemical reactions according to some of our students. They implicitly reach this conclusion when they make mistakes using memorized algorithms for balancing equations or when they need to decide whether matter contains energy. In our previous studies on stoichiometry, using the Knowledge Space Theory (KST)[1], we noted that students tend to start with the symbolic representations, then move on to numerical problem solving and finally to the visualization at the submicroscopic level[2]. Our approach in this study was to start with the fundamental principles and assume that, if students understand the Conservation of Matter and Energy concepts, they should be able to visualize (on the submicroscopic level) that, for instance, the number of atoms on the reactant side is the same as the number of atoms on the product side. Algorithms are then simply procedures for reaching a balanced equation.

This study was done at the university level, with first year general chemistry students using an approach similar to the Chemistry Concepts Inventory[3], but choosing questions which build on each other for developing conceptual understanding. We determined the percentage of correct responses on the tests, documented common misconceptions, and established the connectivity of correct responses, or the cognitive structure, by using KST. Several preliminary results are available, among them: 1) understanding the energy conservation concept came later in the critical learning pathway than the matter conservation concept; 2) the submicroscopic visualization question, underlying the conservation of matter principle, was the last question to be added to the knowledge structure among the matter questions; and 3) in spite of placing the relative energy levels of the reactants and products correctly for a reaction, the students were uncertain about whether stronger or weaker bonds break first and whether energy comes from breaking or making of bonds.

The assumption is often made that students build their own knowledge structure, but our analysis, as well as that of others, indicates that students need a lot more help in doing so than is traditionally given in chemistry textbooks, lectures, discussion sections or laboratories.

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SATL IN ANALYTICAL CHEMISTRY TEACHING

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Analytical Chemistry (AC) is a fast developing chemical discipline. At present, the education of AC is challenged by a complicated body of knowledge. For a time-limited one or two semester course, should we just teach the current analytical technique one by one? Should we have our students learn some things beyond pure technique? Therein the practice of Systemic Approach to Teaching and Learning (SATL) in education of AC is discussed.

Since it was introduced in education of chemistry, SATL has proved to be successful. Fundamental principles underlying in SATL includes the constructivist theory of learning and the current views of brain function.[1] In the process of practicing of SATL we have cognizance of that practice of systems thinking and personal knowledge processing (PKP) would enhance the achievement of SATL. SATL, in nature, is systemic, and it seeks relationships between concepts and makes it clear, up front, to the learner using a concept map-like representation.[2] Systems thinking go beyond concepts and their relationships. System thinking seeks the interaction[3] (interaction between concepts, knowledge modules, system and its environment, or interaction with another subsystem in context of a high-level system, and so on). Learner-centered operation of the interaction makes the students have access to deeper understanding of a coherent body of knowledge. System thinking also seeks interaction dynamics (interaction in context of time domain), and enable the students to grow into a self-motivated person with sustainable developing ability to self-learn later on, to meet the challenge of future development of analytical science and relevant domains. Incorporate system thinking into SATL underlies the fundamental ideas of PKP. By PKP, I mean, the process of transforming the data, facts and concepts into knowledge, and the process of internalizing knowledge into personal wisdom.

To illustrate, there are several teaching cases shared in the paper.

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APPLICATIONS OF SATL IN PHYSICAL CHEMISTRY

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Concepts play a vital role in enabling chemist to deliver. The recently developing concept based teaching methods are likely to play a pivotal role towards the efforts for promoting understanding of chemical concepts. A. F. M. Fahmy and J. J. Lagowski are the leading figures in derive towards concept building of young generation through this novel mode of teaching and learning. However, their efforts, till recently have been mostly organic chemistry specific. Nevertheless, SALTC teaching methods are as well applicable to various other disciplines in chemistry. SATLC methodology can also be used to overcome the problems faced by students in solving numerical, a vital component of Physical Chemistry related curricula. This presentation outlines possible applications of SATLC technique to some basic concepts related to Physical Chemistry.

[SATLC- INITIATIVE]
USES OF SATL & MULTIPLE INTELLIGENCES [MI] FOR TERTIARY LEVEL:
PART-I: BENZENE STRUCTURE ACTIVITY

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Howard Gardner initially formulated a list of seven intelligences (1, 2).

Kornhaber (3) stated that the theory validates educators' everyday experience, and provides them with a conceptual framework for organizing and reflecting on curriculum assessment and pedagogical practices. In turn, this reflection has led many educators to develop new approaches that might better meet the needs of a wide range of learners in their classrooms.

Systemic approach meets the needs of both students and their teachers (4).

Application of systemic approach to teaching and learning linguistics and Math for the first three grades in the primary schools, proved the effectiveness in growing the skills for both reading and writing .This encourage us to integrate both SATL, MI in teaching and learning Arabic, English languages and Math in the first three grades of the primary schools. This was done by designing systemic outdoor activities(5). It was experimented successfully in some primary schools in Egyptian Governorates (Cairo, Alex. Quina)

In continuation of this work we integrated again both SATL and MI in teaching and learning chemistry in tertiary level. This activity was designed by cooperation between Chemistry Staff members [CSM], Music, and Sports staff members by making use of musical, body kinesthetic, Interpersonal Intelligences to enhance logical & Spatial Intelligences in learning Chemistry. The students were performed under supervision CSM, s in cooperation with music and sports staff members in the playing area or the gymnasium hall of the faculty. The performance of the students will be in a team.

By implementation of Benzene structure activity we expected from our students to:

Go in a deep understanding of benzene structure, and create attitudes towards working in a Team & better environment for teaching and learning chemistry.

We introduce this activity as a model could be extended to other topics in organic chemistry or other branches of chemistry.

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FOSTERING IMAGINATION TO ENHANCE LEARNING: ART AND CHEMISTRY

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A dualistic view of knowledge—in which something is simply right or wrong—plays a major role at the level of intellectual development of the majority of freshman science students. The stringent character of college curriculum compels the use of assessments based mostly on algorithmic problem solving and procedural knowledge. As a consequence, students tend to compartmentalize information into tidy, demarcated parts, whereas conceptual understanding and curriculum integration are seriously compromised. Within these constraints, the necessity of finding assessments for introductory chemistry courses that engage students in meaningful learning is paramount, especially for the high-level abstractions of the quantum theory and its apparently inconsistent representations, such as the wave-particle duality.

The *Art & Science Project* (see www.artandchemistry.ca) has been implemented at Vanier College since 2009 with the aim of providing innovative instructional strategies and assessments to foment imagination and creativity in the teaching of chemistry. Its interdisciplinary nature resides in the connections made between scientific models and their representations[1] and the metaphors and analogies depicted in the paintings of 20th century artists, especially René Magritte. Over a period of four weeks, students create an artwork that tries to capture some of the concepts of the quantum world together with a written rationale explaining the connections made. The project demands that students develop tolerance for ambiguity and the capacity for more creative, original, and unconventional thinking. This exercise explores four levels of creative thinking skills[2] (namely fluency, flexibility, originality, and elaboration), which allows students to abstract their own ideas into symbolic representations and engage in evaluation and synthesis, the highest levels in Bloom's Taxonomy of educational objectives. By expressing their conceptual understanding using art and imagination, students can enhance their cognitive capacity, enrich their cultural development, and find joy in the learning process.

Both imagination and creativity appear to be at odds with some of the important cultural values of institutions of higher learning, such as conformity, standardization, and rigor in knowledge generation. However, the proposed assessment is a prototype for activities that can help students achieve an expanded awareness that can permanently alter how they think, construct meaning, and reach an understanding[3].

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TEACHING THROUGH RESEARCH: REVOLUTIONIZING THE FRESHMAN EXPERIENCE

An innovative program has been developed at The University of Texas at Austin that combines the dual missions of the university: research and teaching. Students participating in the Freshman Research Initiative [FRI] engage in an authentic research experience during their first year at the University, while earning introductory laboratory course credit. FRI students learn the required laboratory techniques, along with advanced laboratory techniques, and start conducting original independent research by the end of their freshman year. Analysis has shown that the FRI program has improved student interest in science, retention within the College of Natural Sciences, and performance in non-FRI classes. Here we wish to highlight how both general chemistry laboratory skills and advanced techniques can be taught through a variety of research topics. While there are currently 25 active FRI research groups, or “streams”, we will focus this presentation on three different chemistry streams —organic, analytical and biochemical — to demonstrate how general chemistry laboratory skills are taught in the context of these varied research disciplines. To illustrate the flexibility of the FRI model for teaching freshman chemistry, we will show how each stream teaches four different skills: UV-Vis spectroscopy, solution and dilution preparation, synthesis, and purification. We will also explore the benefits that students gain from the FRI program in their later laboratory and course work and discuss ways in which the program can be adapted to meet the needs of other colleges or universities.

ALIGNING INTRODUCTORY CHEMISTRY EDUCATION WITH THE LOGIC AND LANGUAGE OF MATHEMATICS

Donald Wink

It is common to consider that students who struggle with the mathematical calculations in chemistry do so simply because they do not know some of the fundamental mathematics. However, an examination of the underlying mathematics shows that there may be a gap between how chemists describe calculations and the logic and language of the mathematics. As a result, there are lost opportunities to assist students in transferring their math knowledge to chemistry. This paper will review some of the issues associated with carrying out mathematical operations on expressions, units, relationships, and equations. Examples from stoichiometric calculations, gas laws, and equilibrium will be included.

BRIDGING GAPS BETWEEN SCHOOL AND UNIVERSITY *UNIVERSITY STUDENTS' AND TEACHERS' BELIEFS ON DEMANDS AND STUDY SKILLS IN CHEMISTRY*

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High drop-out rates in chemistry courses during the first year at university indicate problems in bridging the gap between school and university. Gaps could be found with respect to different aspects, e.g. the assessment of knowledge and abilities, interests and expectations or the self-organisation of learning processes[1,2,3].

Whereas most studies have focused on the students' perspectives and results only, this study will compare university students' and teachers' beliefs of demands, learning strategies and interests in chemistry to identify similarities but also differences as additional reasons for non-satisfactory results and perceptions.

The study applies both quantitative and qualitative methods: paper & pencil test instruments / questionnaires are used to analyse the students´ interests, expectations on their studies and prior knowledge in chemistry and mathematics in the first week at university. Group discussions are carried out, too. Three groups which are homogeneous of their study programmes (BA biochemistry, BA business chemistry and BA chemistry) have met three times and discussed about expectations on their studies and difficulties and problems in their studies. Furthermore, learning strategies and time management are covered. Finally, interviews with university lecturers will be carried out in order to compare students' and teachers' beliefs.

The results should not only enlarge the knowledge base about university students´ and teachers´ beliefs on learning and teaching chemistry; they will also be used to improve pre-courses at university by explicitly highlighting different expectations of different groups.

The presentation will discuss results of the questionnaire and prior knowledge tests on the one hand and preliminary results of the group discussions with the students on the other hand. In addition, first considerations regarding to the structure of pre-university courses will be presented.

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INVESTIGATION THE PROBLEM AND SOLUTION STRATEGY IN THE LINKING CURRICULUM BETWEEN VOCATIONAL HIGH SCHOOL AND UNIVERSITY OF TECHNOLOGY-TAKE CHEMISTRY REMEDIAL COURSES AS EXAMPLES

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In recent years, the higher education in Taiwan actively promotes the curriculum mapping. In this process of construction, we found an incoherence problem of chemistry course between vocational high school and university of technology. Few students have never learned chemical course in vocational high school, but they will study the advanced chemical course with students that have basic chemical ability. The purpose of giving chemistry remedial course before new term beginning is to help students without chemical foundation to learn advanced chemistry. In the 2011 academic year, there were 178 freshman finished the remedial course and the progress in their scores is 28.3 averagely. Comparison of the questionnaire results before and after teaching, we find the proportion of the students agreement obviously increase on "I know how to study the chemistry effectively" and "I know the important core concept of chemistry". We found promoting remedial courses is helpful for students, but it still has some unresolved problems.

Key Words: Chemistry Curriculum, Curriculum Mapping, Remedial Course

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WHAT IS THE CONCENTRATION OF STONES AT THE BOTTOM OF THE SEA? – PITFALLS AND ERRORS IN TEACHING OF CHEMICAL EQUILIBRIUM

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Even though discussion about chemical equilibrium in the water solutions of acids, bases and salts is present in most general chemistry courses, there are some "typical" errors which appear in numerous textbooks, even in those well-known and considered the best.[1,2] Thus, the expression for acidity constants (K_a) of the weak acids (*e.g.* acetic acid: $CH_3COOH(aq) + H_2O \rightleftharpoons H_3O^+(aq) + CH_3COO^-(aq)$) is quite often derived from **wrongly** set expression for the chemical equilibrium constant of such a reaction:

$$K_a = \frac{[H_3O^+]\cdot[CH_3COO^-]}{[CH_3COOH]\cdot[H_2O]}.$$

The error is containted in the term $[H_2O]$: instead of so-called concentration, water as a solvent **should be** expressed in terms of molar fraction (x):[3]

$$K_a = \frac{[H_3O^+]\cdot[CH_3COO^-]}{[CH_3COOH]\cdot x(H_2O)}.$$

The equilibrium constant of dissolution of an electrolyte (*i.e.* solubility product, K_s) is also described in almost all general chemistry textbooks. Unfortunately, the derivation of an expression for K_s of certain salt or hydroxide is very often accompanied by using of a completely **senseless** "concentration" of pure solid. For instance, in the case of silver(I) chloride

($AgCl(s) \rightleftharpoons Ag^+(aq) + Cl^-(aq)$), one can often find that K_s is „derived" from

$K_c = \frac{[Ag^+]\cdot[Cl^-]}{[AgCl]}$, where the term [AgCl] "was combined" with K_c, that has given

$K_s = [Ag^+]\cdot[Cl^-]$. The fact is that K_s **should be** derived only from the standard constant:

$K = \frac{a(Ag^+)\cdot a(Cl^-)}{a(AgCl)}$, where the activity of a pure solid is 1 (in this case: $a(AgCl) = 1$).

Finally, it has to be mentioned that the equilibrium constants based on molar concentration of the species in solutions (which is a common way of expressing the K_a, K_b, and K_s) are expressed in units of concentration.[4]

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INFLUENCE OF E-HOMEWORK USE ON STUDENT SUCCESS IN GENERAL CHEMISTRY

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Web-based homework systems are becoming more common in general chemistry as instructors face ever-increasing enrollment and students wanting immediate feedback. Chemistry instructors consider completion of homework integral to students' success in chemistry, yet only a few studies have compared the use of Web-based systems to the traditional paper-and-pencil homework. This study compares the traditional homework system (Fall 2004, Spring 2005, and Fall 2011) to six different Web-based systems: **A**ssessment and **LE**arning in **K**nowledge **S**paces ([ALEKS], UC Regents, ALEKS Corp) Spring 2009 and Fall 2009; Catalyst (WileyPLUS, John Wiley & Sons) Spring 2008; MasteringChemistry ([MC], Pearson) Fall 2007; Online Web-based Learning ([OWL], Brooks/Cole-Cengage Learning) Fall 2005, Fall 2006, Spring 2006, and OWLBook (Vining et al.) Spring 2012; Sapling Learning (Sapling, Sapling Learning) Fall 2010, Spring 2011, SmartWork ([SW], W.W. Norton) Fall 2008. Data from 14 semester classes over nine years consisting of diagnostic pre/post tests, number of successful and unsuccessful students, final semester grades, and student opinion on the use of e-homework systems are analyzed. Results indicate that students are savvy when evaluating the efficacy of using e-homework and instructors should carefully consider options when selecting e-homework systems.

ASSESSING AND COMPARING PROCESSES OF SCIENTIFIC INQUIRY IN CHEMICAL AND BIOLOGICAL CONTEXTS

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Although international research on science education indicates a clear, positive trend favouring inquiry-based instructional practices[1], the influence of the science discipline on teachers' use of inquiry and its impact on the students' skills have largely been ignored.[2] Against this background, the objective of this study is to investigate and compare processes of scientific inquiry in chemistry and biology classes. Central research questions are:

1. To what extent do processes of scientific inquiry in biology and chemistry classes differ?
2. Which correlations between the teachers' beliefs about nature of scientific inquiry, the processes of scientific inquiry carried out in biology and chemistry classes and the students' skills in chemical and biological contexts can be found?

Based on contemporary science education theories[3], a two dimensional theoretical structure describing scientific inquiry in chemistry and biology has been developed. It consists of three *inquiry methods* (modelling, experimenting, observing) and three steps of *scientific reasoning* (formulating questions and hypotheses, planning and performing, analysing and reflecting).
To answer the research questions, the implementation of scientific inquiry in 25 chemistry and 25 biology courses of 10th grade classes (students aged 15) is videotaped and analysed using quantitative coding software. Furthermore, the students' skills concerning *inquiry methods* and *scientific reasoning* in chemistry and biology are assessed with the help of paper and pencil tests for both subjects. The participating chemistry and biology teachers are questioned about their beliefs about nature of scientific inquiry and its domain specific characteristics. All instrument development and data analysis is theory driven.

First results of preliminary studies (N_{Σ}=239) show no significant differences concerning the students' perception of the items' difficulty for chemistry and biology. Moreover, the reliability of most scales is acceptable or good (α=0.63-0.88), only one scale differs with α=0.22. Here, the test items are revised.

Results of the main study will be presented at the conference as well as conclusions for the educational practice.

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TEACHERS' PERCEPTIONS OF CONSTRUCTIVIST PRINCIPLES IN THE RENEWED CHEMISTRY CURRICULUM IN TURKEY

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The renewed secondary chemistry curriculum is in use since 2007 in Turkey. The new chemistry curriculum is based on constructivist approaches. The greatest responsibility in the implementation of the curriculum falls to teachers. If the curriculum has to be succeeded firstly teachers have to perceive and understand it as intended. The aim of this research is to analyze what has been intended by new chemistry curriculum and how chemistry teachers perceive these aims. The study investigated what meanings the current chemistry curriculum attached to constructivist approach and how teachers perceived them and implemented into the practice.

In order to determine teachers' perceptions, case study method was used. Data were collected from 23 chemistry teachers through semi-structured and focus group interviews. Semi-structured interviews have been done face to face with nineteen teachers, while a focus group interview done with four teachers. All interviewees were asked the same main questions and they were allowed to complement and expand the interview questions. The interviews were recorded and then transcribed by the researchers. The interview data were subjected to a content analysis so that each transcribed interview was read in detail to discover important topics, categories and codes.

The result of the study indicated that the majority of the participants did not perceive sufficiently constructivist approach and its principle, how must be learning and teaching environment what methods-techniques must be used, what have to be pupils' role and how assessment must be done in the new chemistry curriculum. Approximately half of the teachers partly perceived teachers' role and which learning-teaching materials or tools must be used according to the new chemistry curriculum. The findings of the study may help academicians, curriculum developers and experts when they develop a new curriculum to consider teachers' view and role in the curriculum develop process. And teachers should not be broken but must be involved in this process.

HOW TEACHING NANOSCALE SCIENCE CAN CONTRIBUTE TO THE KNOWLEDGE OF THE PARTICULATE NATURE OF MATTER

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The importance of nanotechnology is increasing due to scarcity of resources and the trend of miniaturization. Consequently, the implementation of nanotechnological contents into school curricula is a medium-term requirement, in order to allow students to be prepared for the daily use of nanotechnological products.

The nanoscale is located between the scales of atoms and substances. The latter two are conventionally used in chemistry education. However, multiple representations are known to impair students' learning (Johnstone, 1991). There is good reason to believe that education of nanotechnological contents can fill that gap. Moreover, nanotechnological applications require better model-based knowledge, since, in contrast to less recent examples of acquired technologies, the nanotechnological functional structures as well as their constructive elements cannot be perceived. Hence, it can be assumed that understanding nanotechnological applications can improve students' model-based cognition skills. Latter are rarely used by students to explain phenomena (Duit, 1992).

A teaching unit focusing on the size-effect applied in nanotechnology is implemented to the 10th grade. To measure changes on the knowledge of the particulate nature of matter and on model-based thinking a questionnaire (Mikelskis-Seifert, 2002) is used in a pre-post-test design on two groups. Group A is educated in the size-effect of gold and its nanotechnological applications, group B in the properties of bulk gold and conventional technological applications of those properties. The total sample of 150-200 students is subdivided and balanced into two subgroupsaccording to their cognitive ability skills (Heller & Perleth, 2000), interest in chemistry (Fechner, 2009) and the achievements of the knowledge pretest (Mikelskis-Seifert, 2002). The pilote study results and first results of the main study are expected in June 2012.

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PROFILING DIVERSE CHEMISTRY COHORTS THROUGH THE APPLICATION OF CHEMICAL CONCEPT INVENTORY DIAGNOSTICS

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The lowering of entry requirements for several programs of study in science has resulted in a greater diversity in academic ability amongst students entering first-year tertiary chemistry courses at Queensland universities. The parallel implementation of a new senior chemistry syllabus in 2008 has increased the range of prior learning experiences in secondary chemistry and so it is vital for tertiary chemistry educators to focus on addressing both missing and mis-conceptions possessed by incoming first-year students. One application of concept inventories that is of particular interest to us is the potential diagnostic data that can be used to identify students at risk of low achievement or failure in tertiary chemistry studies[1]. We have profiled the range of existing conceptual understanding of first-year students entering chemistry at two major research-intensive tertiary institutions in Queensland in 2011 and 2012. Chemical concept inventory items (CCI) have been drawn from across a number of validated literature instruments and delivered in an online questionnaire in week 1 of semester in the first semester of study.

Analysis of the 2011 outcomes in terms of all participants showed that students with a higher academic ability performed better on the CCI[2]. However when these results were broken down in terms of program, it was found that the academic ability was not the only factor that influenced the CCI results. The program enrolled was a significant indicator of performance which correlated with academic entry requirements for these programs however, students in programs such as nutrition demonstrated greater misconceptions. In 2012, the questionnaire has been modified to include quantitative skills and probing the affective domain through confidence scales[2], outcomes will be presented.

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USE OF A FUEL CELL TO ILLUSTRATE BASIC CHEMISTRY AND PHYSICS PRINCIPLES IN AN UNDERGRADUATE LABORATORY

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Experiments using fuel cells can highlight the basic concepts in chemistry and physics including Avogadro's number, Faraday's laws, the principles of applied electricity, Ohm's Law, energy conservation, power, and efficiency. In addition, while emphasizing the need for use of clean energy resources, one can also introduce the laws of thermodynamic and state functions such as the free energy, enthalpy, entropy and internal energy.

We have designed some experiments, which make use of a fuel cell to teach students how the basic principles of science are applied to create, design, and improve clean energy technologies.

The equipment used in the experiment includes: a module housing the solar cells, an electrolyser containing hydrogen and oxygen storage containers with overflow pipes, the fuel cell, and a load measurement box containing an ammeter, voltmeter, motor with colored disc and a lamp. In the experiments, different light sources were used to power the solar panel.

As an example of the calculations involved, student measures the volume of hydrogen evolved above water along with the temperature and the pressure, and calculates the volume of dry hydrogen at the standard conditions of one atmosphere pressure and temperature of 273 K. Since it takes one Faraday or 96485 coulombs to produce one gram or 11.2 liters of hydrogen at STP, one compares the actual number of coulombs (amperes x seconds – area under the curve of amperes versus time plot) used. In an experiment, we measured the Avogadro's number to be $6.2X10^{23}$ for which the percent error is 3. Other calculations to be reported will be the efficiency of the fuel cell where we calculate energy produced from known amounts of hydrogen and oxygen and compare with the input energy.

In addition, we have used the fuel cell to deliver presentations to promote science, technology, and green energy to the community and the student groups as our outreach activity.

A NEW APPROACH TO TEACHING AND LEARNING THE BONDING CONCEPT

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In Israel, the central developed Matriculation Examination in chemistry is one of the main sources for information on misconceptions of students. The analyses of the Matriculation Examinations in chemistry, over a period of almost 20 years, revealed each year that students have a fundamental misunderstanding and difficulties regarding concepts such as *chemical structure and bonding*, which are essential for understanding many concepts and topics in chemistry (Levy Nahum, Hofstein, Mamlok-Naaman, & Bar-Dov, 2004). No doubt, that the teaching and learning of these concepts is a serious and continuous problem.

In this study we will present several factors leading to these misconceptions. More specifically, we will focus on how the structure and content of the National Matriculation Examinations conducted in Israel influence chemistry teaching and learning. We think that this type of assessment can be a major factor in the development of students' learning difficulties and alternative conceptions. Based on the above, a long-term collaboration between prominent scientists, researchers in chemistry education, and expert teachers, an innovative program has started, aimed at teaching the chemical bonding concept, which follows a holistic approach to curriculum was developed and implemented in 11^{th}-grade chemistry classes in Israel since the academic year 2005/6. Its general approach relies on basic concepts such as Coulombic forces and energy at the atomic level to build a coherent and consistent perspective for dealing with all types of chemical bonds.

The framework proposed by Levy Nahum, Mamlok-Naaman, Hofstein, & Kronik (2008) introduces the elemental principles of an isolated atom; this is followed by discussions of general principles of chemical bonding between two atoms; the primary purpose of this stage is to provide a qualitative description which gives a very clear, intuitive answer to the question which puzzles many students, 'what *really* causes atoms to interact and form a chemical bond?' The general principles are then used to present the different traditional categories of chemical bonding as extreme cases of various continuum scales. Equipped with this knowledge, students can then construct a coherent understanding of different molecular structures and properties.

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CONSTRUCTING THE CHEMICAL BOND CONCEPT IN SWEDISH HIGH SCHOOL: INSIGHTS FROM A CASE STUDY

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Chemical bonding is a core idea in high school chemistry in Sweden, as in other curriculum contexts. It is also well known that many students find chemical bonding a challenging topic (Levy Nahum, Mamlok-Naaman, Hofstein & Taber, 2010), and it is common for students to develop alternative conceptions in this topic (Taber & Coll, 2002). This paper discusses aspects of the thinking of a Swedish high school student, Jesper, during his first year of high school in Sweden (when he was aged 16-17 years), when key core chemical concepts were formally taught. The case study considers how the development of Jesper's construction of the chemical bond concept was influenced by his prior thinking about the nature of matter at the submicroscopic level.

The case is contextualised in terms of the nature of both the classroom teaching Jesper experienced and the general organisation of chemistry education in Swedish school system. It has been reported that the curriculum regime in Sweden offers students a limited basis for understanding the submicroscopic models of matter upon which high school chemistry learning depends (Adbo & Taber, 2009). The case illustrates that in Sweden, as well as has been found elsewhere, learning of canonical versions of scientific concepts is compromised by the abstract nature of chemical concepts and the (sometimes idiosyncratic) informal ideas students bring to class and which provide the interpretive resources for making sense of the curriculum. The case also suggests that the Swedish curriculum context offers considerable scope for students to develop alternative conceptualisation of the nature of matter prior to any in-depth formal teaching of models and concepts set out in the curriculum.

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VISUALIZING CONDENSATION: WHAT DO THE STUDENT GENERATED ANIMATIONS OF CONDENSATION TELL?

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Learning chemistry involves understanding chemical phenomena at three levels: the macroscopic level of the observable; the symbolic level of symbols, equations, and mathematics; and the submicroscopic level of the molecular, atomic and kinetics (Johnstone, 1993). Understanding chemical phenomena particularly depends on visualizing the structure and the changes taking place at the submicroscopic level. Investigating mental models of students on chemical concepts and how they visualize those concepts would be helpful in designing more effective learning environments and strategies. However, mental models of students, which are obtained from drawings and explanations, are limited for the concepts involving dynamics. For this purpose, an animation-developing software, K-Sketch, was used in eliciting mental models of students on condensation which involves dynamic processes and motion. This study aimed to investigate student generated animations on *condensation of water* and to compare them with students' *static* mental models which were created on paper.

Forty-four 11th grade and forty-one 10th grade students participated in the study through a 2 hour workshop where in the first part they learnt how to use K-Sketch for 60 minutes and in the second part they generated 2 animations on the given topics for another 60 minutes. Before and after the implementation of the workshop students took a pretest of conceptual understanding of intermolecular forces, and a drawing test of storyboarding the animation of the process of condensation. The mental models given on papers were compared with the dynamic ones created by the animations and the differences were determined. In addition, student generated animations were analyzed and categorized based on the features emphasized in the animations representing their dynamic mental models.

The results of the analysis showed that the static mental models were found to be limited to structural representations, whereas dynamic mental models focused more on the process of condensation, motion of the molecules, and the macroscopic changes. The animations created using K-Sketch were found to lack in accuracy in terms of the process of condensation, orientation of molecules, and representation of hydrogen bonding. In addition, macroscopic and symbolic features were found to be included in the majority of the animations and some misconceptions related to the formation of condensation were also determined.

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STUDENTS' UNDERSTANDING OF CHEMICAL BONDING
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Chemical bonding is regarded by most students to be one of the most challenging topics in chemistry. This study aims to investigate students' misconceptions in chemical bonding. Thirty first year diploma (chemistry & biology) students from Tunku Abdul Rahman College, Kuala Lumpur, Malaysia, participated in the study. Participants were asked to take a diagnostic assessment. It consisted of ten multiple choice questions and two open-ended questions on chemical bonding. The results show that they had difficulty in understanding chemical bonding concept especially covalent bond. Discussion was conducted to identify their misconceptions about the chemical bonding generally and covalent bond specifically. Interpretations of the results are provided and implications for chemistry teaching and for further research are discussed.

FIRST YEAR PRE-SERVICE PRIMARY SCHOOL TEACHERS' CONCEPTIONS ABOUT CHEMICAL BOND

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In Slovenia. pupils learn about basic concepts of covalent and ionic bonds in primary school (pupils aged 13 and 14 years). They upgrade these concepts in secondary school, where they also learn about the metal bond and intermolecular bonds (students aged 15). Research has shown (see review by Levy Nahum, Mamlok-Naaman, Hofstein & Taber, 2010) that these concepts are identified by teachers, and also by learners, as difficult and highly abstract, so they commonly lead to students developing misconceptions also at the university level. In Slovenian textbooks for primary and secondary school chemical bonds are presented quite traditionally and also teachers use such explanations, so it is necessary to be aware of students' types of conceptions (misconceptions) about chemical bonds.

It is suggested that teachers (with support by researchers in chemistry education) should develop new, more scientifically and pedagogically sound learning material to support the adequate teaching of these concepts. It is also important to link the chemical bond concepts with the structure of matter and its properties when learning about substances. To correctly understand chemical bonding and its influence on substance properties it is important to develop students' spatial abilities. It is important to understand relations between the structure of substances, its particles or quanticles (Taber 2002), which should be presented by different visualization approaches (i.e. models, submicrorepresentations).

The research problem of this study is to document and explain first year pre-service primary school teachers' mental models of chemical bonds and before attending chemistry course at the university level. 126 pre-service primary school teachers in academic year 2011/12 participated in this study. Students' conceptions about chemical bond were identified and explained by the knowledge test developed for this study. It comprises items based on the submicrorepresentations and models representing substances with different chemical bonds and chemical properties. Students' understandings presented in the knowledge test were also explained by results obtained from semi-structured interviews with selected students. Secondary school teaching approaches as viewed by students were identified by the questionnaires.

Results of this study will be presented at the symposium. According to the students' conceptions described in this study, identified teaching strategies in Slovenian secondary schools and proposals from the research literature, some contemporary teaching and learning approaches will be suggested. These teaching approaches would be also used to overcome weak points identified by this study when introducing chemistry in context topics to the pre-service primary school teachers at the university level.

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THE EFFECTIVENESS OF COMPUTER-ASSISTED INSTRUCTION (CAI) IN OVERCOMING MISCONCEPTIONS IN RELATION TO CHEMICAL BONDING

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In this study, the effectiveness of Computer Assisted Instruction (CAI) on conceptual understanding of chemical bonding was investigated. The study employed quasi-experimental design involving pre-university students; 25 in an experimental group and 25 in a control group. The Chemical Bonding Concept Test (CBCT) consisting 10 two-tier questions was used as a tool for the data collection. The CBCT were administered in the form of a pre-test and post-test. Analysis of scores of the two groups in the pre-test and post-test were compared and a statistically significant difference was found in experimental group. It was also noticed that students from experimental group were more successful in remediating the misconceptions than students from control group. The result of this study suggest that understanding of chemical bonding can be improved by the use of Computer Assisted Instruction (CAI) materials.

HOW KNOWLEDGE ABOUT INTRA- AND INTER-MOLECULAR BONDING IS ORGANIZED IN GENERAL CHEMISTRY TEXTBOOKS

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Chemistry is regarded as a difficult subject for students. The psychology for the formation of chemical concepts at the submicroscopic level, such as the bonding concepts, is quite different from that of the macro/'normal' world (Johnstone, 2000). Textbooks are written in conformity with the curriculum; hence the role of the textbook is also crucial in the teaching process. The evaluation of textbooks is considered a necessary and very useful process that contributes to the upgrading of the provided quality of teaching.

In this study, we examine how knowledge about intra- and inter-molecular bonding is organized in a number of general chemistry textbooks. In our analysis, we also include the organization of the corresponding knowledge on bonding of the States-Of-Matter Approach (*SOMA*) to introductory chemistry (Tsaparlis, 2000). Our analysis is based on (a) the basic elements of the organization, and (b) the links that connect the basic elements among themselves.

The following aspects of bonding were examined: presentation order of intra-molecular bonds; placement and method of presentation of inter-molecular bonds; physical states and their connection with the types of bonding; metallic bonding; semi-covalent (dative covalent) bond; electronegativity and bond polarity; the bond continuum; the octet rule. The evaluation was based on chemistry teachers' categorization of the links.

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MEETING CHEMISTRY AND CLIMATE LITERACY OUTCOMES IN INTRODUCTORY UNIVERSITY CHEMISTRY

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Global climate change is one of the most pressing environmental challenges facing humanity. Many of the important underlying concepts require mental models that are built on a fundamental understanding of chemistry, yet connections to climate science and global climate change are largely missing from first-year undergraduate chemistry courses for science majors. This workshop will explore new learning materials and pedagogical strategies that aim to improve the link between core chemistry curricula and sustainability education, develop faculty expertise required to place chemistry content in an interdisciplinary context, and effectively use visualizations and case-based approaches to support an understanding of complex science. Participants will have the opportunity to investigate, test, and evaluate digital learning objects (DLOs) that have been developed to take advantage of the correlation between climate literacy principles and core chemistry content. Specifically, the workshop will consist of hands-on computer work with DLOs covering several of the following example topics: isotopes and their relevance in determining historical temperature records, IR absorption by greenhouse gases, acid/base chemistry and impacts on changing ocean pH, and combustion of fossil fuels and climate change.

LEARNING CHEMISTRY THROUGH THE GENERATION OF SELF-EXPLANATIONS

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In science, the ability to use a concept in explanation and argumentation, that is, making sense of *how* and *why* phenomena occur, is evidence of sound understanding of that concept (Ford & Wargo, 2011). Therefore, one promising strategy for promoting learning in the sciences is to encourage learners to practice this ability. This may be accomplished by having learners generate their own explanations for phenomena (observed or hypothetical) as well as statements or conclusions from others (Siegler & Lin, 2009). In this context, self-explaining refers to the generation of inferences about causal connections between objects and events. As a metacognitive strategy, self-explaining is effective in helping learners develop conceptual understanding of material (Answorth, 2003) and it influences aspects of cognition, including acquisition of problem-solving skills (Siegler & Lin, 2009). In spite of its potential, implementation of this instructional approach is only rare. Monological discourse, which posits the instructor as the source of content and the students in the role of passive receivers, prevails in tertiary chemistry education. On the other hand, dialogic instruction is proposed as a means of supporting understanding; furthermore, Ford and Wargo contend that "to truly understand a scientific idea is to have a dialogic relation with it" (2011).

This study investigates the use of different levels of self-explaining to promote engagement in dialogical interaction of learners with the contents thereby promoting learning. The premise of this work is that higher self-explaining demand will result in more effective learning experiences. US General chemistry students were assigned to random self-explaining conditions and their performance on a transfer task was used to assess their understanding of fundamental concepts in thermodynamics. This presentation discusses the study design and preliminary results.

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DO BRIDGING COURSES HELP STUDENTS' UNIVERSITY STUDIES? REFLECTION ON OUTCOMES

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Bridging courses designed to support students who commence tertiary education are widespread, and some evidence for the value of semester-length courses has been reported. Little attention, however, has been paid to short-but-intense bridging courses, and empirical evidence of their effectiveness is particularly sparse. Surprisingly, only a handful of studies have examined the efficacy of chemistry bridging courses within the past 20 years. Three studies have looked at small groups of around 20 students for one-semester long programmes[1-3] while another investigated student attitudes to chemistry[4] and an online biochemistry bridging course has been described.[5] The study presented here followed the academic performance of a cohort of students enrolled in a first year chemistry unit of study designed for those with little or no background knowledge of chemistry. Our presentation will focus on the effect of participation in the chemistry bridging course on students' academic performance in the end of semester examination and whether participation equally promotes understanding in all areas covered. We have determined the strength of the linkage between prior knowledge of chemistry and performance in the end of semester exam, and explored the reasons for any differences observed. In particular, the value of the week-long intensive mode bridging course offered by the University of Sydney was analysed. Quantitative and qualitative data were collected. Our results show that participation in the chemistry bridging course is associated with 'bridging the gap' in academic performance between students with a very weak and those with a strong background. While the content of the bridging course is a significant contributor to academic success, so too is the confidence in their own learning that the course engenders among participants.

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FACULTY GOALS FOR UNDERGRADUATE CHEMISTRY LABORATORY

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Faculty perspectives of the undergraduate chemistry laboratory were investigated using a mixed methods study to articulate the goals, strategies, and assessments used in undergraduate teaching laboratories. Interviews were conducted with 22 faculty engaged in teaching or supervising undergraduate laboratories from different types of institutions, chemistry disciplines, and course levels. Faculty goals for general chemistry, organic chemistry, and upper division laboratories were elucidated and compared across courses and institutional types. Additional comparisons were made between faculty who had received grants to implement changes in laboratory and those who had not. Based upon the results of the interviews and analysis, a survey of faculty goals for undergraduate laboratory was created and distributed in the U.S. to over 1800 faculty, with slightly over 300 faculty responding. Results from the survey, with comparisons across courses, institutional types, and funding will be presented.

INTERNATIONAL STUDENTS' QUESTIONS ABOUT CLIMATE CHANGE

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This study investigated what type of questions the youth ask about climate change, and whether gender, age or continent of origin has an effect on the types of questions asked. The participants (N=250) in this study were 16 to 19-year-olds representing different countries from Europe and Asia. The data was collected from the Millennium Youth Camp 2011 applications that the students filled out. The students came from scientifically and mathematically oriented schools or had shown interest towards these subjects through competitions or their own research. The applicants were asked to present questions that they would want to find answers to regarding climate change. A total of 481 questions were asked. The nature and quantity of the different types of questions were analyzed by content analysis.

The results showed that scientific issues were presented by most applicants (80,0%). Moral issues were also popular (52,8%), but societal issues, on the other hand, were not as popular (22,4%). Gender, age and continent of origin did not have a significance on these results.

From the subgroups, it was seen that though scientific questions were common, they mainly focus on the very basics of climate change, suggesting that basic knowledge is lacking. Furthermore, the types of moral questions show that the youth are not content with only knowing about climate change, but they want concrete advice on how to combat the issue. However, even though moral questions were popular, the youth do not think much of what they themselves could do to change things, but rather, present their concern at a less personal level. Concerns over how to deal with climate change were also seen in the societal questions, out of which 70% were concerned with either the effects of climate change or how society could cope with climate change.

To conclude, this research gives educators and curriculum planers ideas on how societal and moral aspects could be implemented to education when dealing with socioscientific issues such as climate change.

HOW DOES A CONTINUOUS PROFESSIONAL DEVELOPMENT (CPD) PROGRAM INFLUENCE TEACHER'S PRACTICE?

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In the last 15 years, Chemistry teachers in Israel were involved in a reform regarding the way chemistry is taught and learned. This included integration of inquiry-type experiments into their chemistry classroom laboratory, termed the Inquiry Chemistry Laboratory (ICL)[1]. Teaching according to the inquiry approach is quite different from the traditional way of teaching[2]. Inquiry-based teaching is a complex and sophisticated way of teaching that demands significant professional development[3,4]. Teachers who teach by the inquiry approach should develop new pedagogical-content knowledge if they want to become accomplished teachers[5]. This study presents a case study of one Chemistry teacher – Judy, who was one out of fourteen experienced chemistry teachers that participated in a workshop at the Department of Science Teaching, the Weizmann Institute of Science. This study was a part of a bi-national program (with King's College London) in which a continuous professional development (CPD) program was tried in six different domains. The main goal of the study was to investigate the professional development over time, of those chemistry teachers who were involved in this program.

Our emphasis was on teachers who implemented an inquiry-type approach in the classroom laboratory for the first time. The teachers' development was followed by protocols assembled in a portfolio that was used to demonstrate evidence-based practice in the inquiry-based chemistry laboratory. Judy was one of the teachers who were also videotaped while conducting inquiry-type experiments in her class and were interviewed immediately after the laboratory session. Our analysis of Judy's development revealed that she was challenged by teaching the inquiry approach, and underwent a rather comprehensive change in her way of teaching and in perceiving her role in the laboratory. In addition, Judy became more reflective and more aware of her practice.

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COMPARISON OF THE EFFECTS OF MODEL – BASED AND COMPUTER – BASED INSTRUCTION ON 9TH GRADE STUDENTS' SPATIAL ABILITIES AND CONCEPTUAL UNDERSTANDING OF IONIC LATTICE

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Understanding and representing the three dimensional spatial spaces that surround the chemical entities and events have been a challenge for chemistry. As (Barke and Engida, 2001) reported true understanding of chemistry concepts requires a sufficient level of spatial ability. Although the significance of spatial ability in chemistry education has been evidenced substantially, three is still a lack of agreement on how to teach spatial ability and how to integrate spatial activities across the school curriculum. As the report of National Research Council (NRC, 2006) declared spatial ability was not just undersupported, but underappreciated, undervalued and therefore underinstructed.

This study was designed for two main purposes. The first one is to develop and carry out two different instructional activities which were computer based modeling and physical modeling for two different treatment groups by switching the treatment order. The second one is to improve the spatial ability and conceptual understanding of ionic lattice structure of students during the 9^{th} grade chemistry lesson. The results of the analysis indicated that mixing the two modeling tools improved statistically significant the spatial ability and the conceptual understanding of the ionic lattice. The results of the study also indicated that regardless of the treatment order, the spatial ability and the conceptual understanding of the both treatment groups promoted statistically significant.

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CLASSROOM IMPLEMENTATION OF CONTEXT-BASED CHEMISTRY: LEARNING STYLES OF STUDENTS AND THEIR ACHIEVEMENT IN CHEMISTRY

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Context-based approaches hold the notion of using contexts as the starting point for the development of scientific understanding. Curricula adopting context-based approaches are widely-used throughout the world with an expectation to address problems in science education. Considering the increasing number of studies focusing on context-based approaches recently, it will be of interest to a myriad of science educators to see the relationship between learning styles and achievement of students in a context-based course.

Sunar and Geban's analysis of studies elaborating the development of projects adopting context-based approaches to science teaching, shows that what is mentioned frequently from one project to another is the importance of student participation. Regarding the focus of this study, which is a context-based Salters Advanced Chemistry (SAC) course, one may wonder how student participation is situated throughout this project. Campbell et al.[2] expressed Salters' view as 'The most important single factor influencing learning is the active engagement of the learner with the material. Obtain this and teach by whatever methods retain this engagement'. Furthermore; Bennett et al.[3] emphasizes two design criteria for Salters curriculum, one of which is 'The course should include wide range of activities in which students could actively engage'.

Bearing the importance of student participation in mind, this study aims to shed light on the relationship between learning styles of students and their achievement in SAC course as expressed in terms of their end-of-term chemistry grades. In order to achieve this aim, two A-level chemistry classes in a sixth-form college were observed for two months to ensure whether classroom instruction was implemented as intended and Learning Styles Inventory developed by Grasha-Riechmann[4] was administered to all students enrolled. This instrument is distinct from other learning styles instruments in that it is based on students' responses to actual classroom activities rather than on a more general assessment of personality or cognitive traits. Analysis of data revealed that high *collaborative* and low *avoidant* students were the ones who got higher achievement scores whereas high *avoidant* students were the ones below average. An awareness of this can contribute to identifying some potential problem areas in context-based courses and help teachers augment their methods of presentation during their instruction.

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VARIETY OF TEXTBOOKS AND ITS INFLUENCE ON QUALITY OF CHEMISTRY EDUCATION IN POLAND

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The present system of education in Poland was introduced in 1999. Education process is divided into a few stages: pre-school, six-year primary school, where there are two phases of three years, followed by 3 years of study in middle school and continue their education in various secondary schools. This reform also introduced significant changes in the curriculum, which was to improve the quality of education.

On one hand, the reform has allowed greater flexibility in how teachers implement the material, by allowing the selection of school curriculum and textbooks from a list of approved for use by the Ministry of Education. Textbooks that are approved for use must contain the contents of the core curriculum, but the presentation of this content can be different and it is verified by the reviewers. The number of authorized school textbooks used to study nature and to learn chemistry varies from a few to a dozen on each of the stages of education.

On the other hand, a large number of school textbooks, the variety of content expanding the core curriculum introduced into the textbooks, as well as considerable variation in the form of presentation of content and its relevance to the scientific achievements in the field of chemistry, introduces confusion into the process of education.

This paper shows how the chemical contents are implemented in a variety of ways and chemistry textbooks at various stages of education, and reveals the errors or out-of-date conceptions that appear either in the textbook or illustrations included inside.

In the article there are also mentioned some problems that a pupil who changes a school during the learning phase can come across. These problems are associated with the change of :

- the textbook,

- the concept of teaching,

- the order of introducing new content.

Moreover there are some inconveniences to teachers who teach at further education levels students who have learnt different content from different textbooks at previous stage of education.

IS THERE A DIFFERENCE BETWEEN GENERAL CHEMISTRY TEXTBOOKS PUBLISHED IN DIFFERENT COUNTRIES?

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Textbooks are an important part of teaching and learning chemistry and in some countries even assume the role of the curriculum. Research in chemistry education has recognized the importance of writing textbooks within a history and philosophy of science perspective. The objectives of this presentation are to compare the presentations of: a) Nature of science (NOS) in general chemistry textbooks published in U.S.A. and Venezuela; and b) Atomic structure in textbooks published in Korea, Turkey, U.S.A., and Venezuela. Among other aspects, nature of science deals with: 1) Tentative nature of scientific theories; 2) Theories do not become laws even with additional evidence; 3) There is no universal step-by-step scientific method; 4) Observations are theory laden; 5) Scientific knowledge relies heavily but not entirely on observation, experimental evidence, rational arguments, creativity and skepticism; 6) Scientific progress is characterized by competition between rival theories. A historical reconstruction of atomic structure shows that the following aspects are important: 1) Cathode rays as charged particles or waves in the ether (Thomson); 2) Determination of mass-to-charge ratio to decide whether cathode rays were ions or a universal charged particle (Thomson); 3) Nuclear atom (Rutherford); 4) Probability of large angle deflections is exceedingly small as the atom is the seat of an intense electric field (Rutherford); 5) Single/compound scattering of alpha particles (Rutherford); 6) Paradoxical stability of the Rutherford model of the atom (Bohr); 7) Evaluation of the hydrogen line spectrum (Bohr); 8) Deep philosophical chasm (Bohr). Results obtained from different publications show that on both topics (NOS and Atomic structure) most textbooks ignore various aspects of history and philosophy of science and their presentations have very little differences. It is interesting to note that in spite of the cultural differences (U.S.A., Venezuela, Turkey & Korea) textbooks present a very similar empiricist epistemology.

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THE TEACHING PROCESS OF CHEMISTRY IN HIGH SCHOOL EDUCATION OF REPUBLIC OF CUBA

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A brief historical review of the situation of education in 1959 is made; this is the year of the triumph of Cuban revolution and its further development. Characteristics of the pre-university education in Cuba are raised, as well as some of the principal regulations of the Ministry of Education for this teaching level. Certain strengths in the teaching of science in Cuba and particularly in chemistry are expressed. This study aims to analyze the correspondence between the bibliography and the implemented study programs in pre-university education.

In this work, various changes in the study programs and textbooks during the last years are treated, making an analysis of the situation of the bibliography currently used in the three grades of this teaching level, which serves the preparation of graduates to continue their studies at universities. It analyzes the correspondence between the objectives we aim to achieve in the existing programs and in the methodological indications with the bibliography used today.

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INTERACTIVE LEARNING CHEMISTRY IN RUSSIAN PEDAGOGICAL UNIVERSITIES

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There are new educational objectives in chemistry teaching at the pedagogical university that include the formation of not only chemical, but also general, cultural and professional competences. The educational system of all Russian pedagogical universities is able to give students knowledge of good quality in chemical theory, practice and good laboratory abilities. Society expects a pedagogical university graduate to be not as much a chemist in scientific lab or factory, as a modern intellectual chemistry school teacher. We use methods and techniques which integrate the basic interactive methodology and project-based teaching chemistry with modern possibilities of information technology. This idea is revealed using the example of a training project on colloid chemistry. Students were invited to participate in the project for the educational site «The history of colloid chemistry» https://sites.google.com/site/kolloidnaahimia/. The project objective was to create an educational resource − substantial and fascinating at the same time. Educational reasons for students were *a*) to study the discipline consciously through the prism of outstanding scientist individualities as well as the history of colloid science, *b*) to acquire skills of using modern information technologies for scientific and pedagogical activities, *c*) to work out chemistry-related materials and training techniques for future careers. The site structure, technical and methodological pages were created by the project manager. Then students fill the main colloid chemistry content; i.e., create pages about personalities, interesting facts and events in the area of colloid science. Such a work introduces students to the culture of thinking, the ability to perceive, synthesize and analyse information, to set a goal , and to choose ways to achieve it. Creation of a page *a*) requires the students' activity to use basic techniques, ways and means of information receiving, storing and digestion, *b*) forms willingness to work with computer, *c*) trains ability to use a knowledge of modern natural science picture of the world, *d*) improves students' knowledge of foreign languages to the level of receiving and evaluation information in the field of their professional activities. In the course of 2010/2011 and 2011/2012 academic years, the project was tested actively and rated (according to discussions with students and teachers) as bearing the interdisciplinary nature of two interrelated areas, one of which is course content (chemistry, physics, history, philosophy, culture) and other comprises students' educational activities (chemistry teaching methodology, computer science). Students like the proposed form of education and evaluate it as successful and forward-looking. Therefore some of them are planning to use it in their own professional educational activity.

ADAPTIVE TEACHING OF CHEMISTRY AT EVENING SCHOOLS IN RUSSIA

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The Law «About education» and the State educational standards of the Russian Federation direct teachers to an organized educational process in accordance with individual characteristics of students. This principle is actual for all types of comprehensive schools, especially for evening schools. The evening school has its own specific character, first of all the specificity of a contingent of students: uneven-age students; different levels of knowledge and ability to study; different social groups, characteristics of perception, memory, attention etc. That's why the role of adaptive teaching is growing.

Adaptive chemistry teaching is chemistry teaching which takes into account the individual characteristics of students (predominating modalities, information processing styles, different levels of knowledge), and adapts as much as possible the educational process for them.

In adaptive chemistry teaching the dominant role is assigned to the didactic aims as the means of steady development of students. These aims (stages) are: 1. Diagnosing predominating modalities, information processing styles and level of students' chemical knowledge, etc. 2. Studying new material (in the form of frontal or group work in view of dominating modalities, information processing styles and levels of knowledge). 3. Monitoring of the quality of learning new material. 4. Correction of knowledge (getting rid of mistakes and gaps in knowledge, application of studying material, generalization and systematization of knowledge). 5. Inspection and self-appreciation.

According to the above-mentioned modalities and information-processing styles, we selected the most preferable methods and means of adaptive teaching of chemistry. For left-brained students with audible modality, the most preferable methods of learning chemistry are: lecture, conversation, discussion, listening to audiocassettes etc. For students with visual modalities: demonstration of chemical objects, charts, videos, models etc. For right-brained students with kinesthetic modality: experiments, laboratory works, practical works, didactic games, making devices and models etc. At the stage of adaptive correction of knowledge the preference is given to an individual and group work with 12 different types of adaptive tasks, taking into account individual-typological characteristics of students.

First of all, the system of adaptive chemistry teaching should take into account its didactic aims, the individual characteristics of students, predominating modalities, information processing styles, adapting to them the most preferable methods and means of training. We consider that our system will make it possible to achieve a steady quality of chemistry education of students.

MULTILEVEL METHODOLOGICAL PROGRAMS FOR PRE-SERVICE CHEMISTRY TEACHERS IN RUSSIA

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The development of multilevel methodological programs for students of pedagogical universities should be regarded as one of the priorities and important factors for teacher education in Russia. Nowadays a primary aim of these programs is the development of methodical competence in chemical education that is the constituent part of the professional competence. According to the up-to-date requirements for higher education, the methodological course is aimed at the development of readiness and ability of students to apply their knowledge, skills and values in constantly changing conditions, to work successfully in the educational system, and to get involved in innovative activities on the basis of common cultural and professional competencies that they have studied.

The multilevel methodological program for students involves their studying the bachelor's and master's programs of chemical education. Each of these levels is an integral system of training of a respective specialist. In the meantime each of these parts is the element of a common system of training of a specialist of chemical education. Change of the purposes of trainings of bachelors and masters of chemical education requires certain correcting of their contents. Such questions as theory and methods of chemistry teaching on the basic level in secondary school; modern innovative technologies and technological methods in the chemistry teaching; organization of extracurricular activity in chemistry; targeted profile training of pupils to choose the profile for further education (development of appropriate elective courses); carrying out of the qualifying survey related to the analysis, selection and processing of information for its further application at the base level; independent work to decide the academic tasks; exam oriented on practice; educational and research practice; pedagogic (methodological) practice are considered in the content of corresponding training of bachelors of chemical education. The questions related to the theory, methodology, methods, innovative technologies of chemistry teaching (more complex than those studied in the 1st level), carrying out extracurricular activities with pupils who studied chemistry at the profile level and development of appropriate elective courses are considered in the content of the educational training of 2nd level studies. Much attention is paid to the formation of research skills related to the carrying out of these activities.

INQUIRY BASED TEACHING IN TURKEY: A CONTENT ANALYSIS RESEARCH REPORTS

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Inquiry-based teaching (IBT) enhances students' critical thinking abilities and help students to act as a scientist with using scientific method while learning. Therefore IBT is seen as an active learning approach and it is used in student centered education. The aim of this study was to analyze research related to inquiry based teaching through published research reports in the form of full papers and thesis by Turkish researchers. This is a content analysis study which is commonly used in qualitative approaches. For these purpose national and international journals and data bases were reviewed and totally 43 studies include 23 papers and 20 theses published in the last ten years were analyzed in terms of methodological approaches, data collecting tools, samples, data analysis methods and also content of the studies.

Each paper and thesis selected for analysis is subjected to a content analysis by using "*Paper Classification Form* (PCF)" developed by the researchers. In studies published by Turkish researchers the most striking facts are subjects and design–methods of the papers. Studies focused on teaching are most frequent with 82.4% among others. Regarding the research methods, quantitative approaches were the most common with 67.6% and 55.6% quasi experimental research method applied in national and international reports respectively. Commonly used data collection tools were well known test such as achievement, aptitude, attitude, perception and personality tests together with alternative assessment tests. Most widely studied samples were selected from the primary level in national papers while undergraduates were mostly selected as subjects in the international studies.

The findings of this study indicated that inquiry based teaching is a new research area in Turkey and mostly practiced in science and technology education at primary level. This study may help researchers in other areas realizing practicability of inquiry in teaching and apply it into their disciplines.

THE PATHWAY TO INQUIRY BASED SCIENCE TEACHING

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PATHWAY is a European Project (FP7) that faces the challenge of facilitating the wide adoption of Inquiry-Based Science Education (IBSE) in primary and secondary schools in Europe and beyond. It involves 25 partners from 15 countries collaborating to propose a standard-based approach to teach science by inquiry. Within this project we developed an instructional model with corresponding chemistry teaching materials to help teachers to implement inquiry learning into their teaching, to organise effectively their instruction, to implement necessary changes and to develop the diagnostics and intervention skills necessary to plan and diffuse innovation in their own contexts.

The goal of our closely related research project is to investigate the implementation of the Inquiry-based learning approach into the teacher education. Inquiry learning science activities encompass a broad spectrum ranging from strongly teacher-directed to strongly student-directed[1]. Schwab[2] devised a scale containing three levels of openness. These refer to the degree of student involvement in the inquiry process, the degree of teacher intervention and the student's scientific background regarding the inquiry subject and relevant working methods. Accordingly, we implement open and guided types of Inquiry and investigate their impacts on pre-service teacher`s views of scientific inquiry. To assess these views we use an open-ended instrument[3]. Data were collected in a pre-post design. Moreover, we collected process data concerning the implementation of the learning approach with the help of video analysis.

The overall goal is to provide direct experiences for pre-service teachers in conducting inquiry projects in order to use the developed skills to guide their own students in inquiry learning. Results of the PATHWAY-Project and the main study of our research project will be presented at the conference as well as conclusions for the educational practice.

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INQUIRY BASED LEARNING – DESIGN VERSUS RESEARCH

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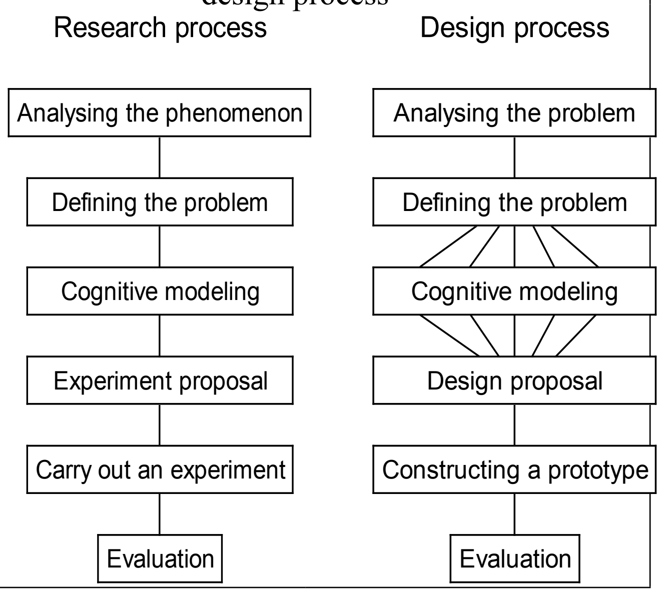
The EU funded FP7 project ESTABLISH aims at the enhancement of Inquiry Based Science Education (IBSE) through development of teacher education programmes using specifically developed inquiry units. These units have been developed for use in second level teacher education and have been implemented in a series of teacher education workshops, both for pre-service and in-service teachers. Following the workshops, teachers will use elements of the units in their classes and also be supported and encouraged to develop and adapt their own materials for use in inquiry classrooms, building up on former frameworks and experiences with Inquiry Learning [e.g. 1-3]. An evaluation will accompany this process, both looking at the teachers´ and their students´ perception of the IBSE approach.

To offer the students not only a "school-oriented" but also a more authentic insight into inquiry based science and technology, all units incorporate an industrial involvement through ICK – industrial content knowledge, which highlights the relevance of/to industry and specifies the type of industry link(s) involved. Scientists design technical systems for their research and often engineers do scientific research as part of their product design. Students should be involved in both research projects and design projects, as depicted in Figure 1. The similarities and differences regarding aims and connecting procedures should be discussed, also the differences between such an ideal structure and real process structures. The ESTABLISH IBSE approach and the involvement of industry will be discussed by presenting exemplary chemistry units.

Figure 1: Comparison of research process and design process



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THE ANAPOGIL PROJECT: INCORPORATING GUIDED INQUIRY INTO ANALYTICAL CHEMISTRY

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Analytical chemistry is often presented in textbooks and perceived by undergraduate students as a series of formulas and problem-solving algorithms. Students often have little opportunity to grow the process skills critical to the practice of analytical chemistry. Two NSF sponsored workshops were held in 1996 and 1997 at which a gathering of analytical chemists from industry, government and academia met to express their concern that recent college graduates were ill-prepared to function as analytical chemists in their first jobs (1). The report issued from this workshop called for an overhauling of the analytical chemistry curriculum to include active learning approaches, such as problem based learning and guided inquiry methodologies, so students could develop the skills they needed to be more effective scientists in general and more productive analytical chemists in particular.

A consortium of analytical faculty members involved in curriculum development and chemical education research have developed instructional materials for analytical chemistry based on the well-established POGIL model (www.pogil.org). In POGIL (Process Oriented Guided Inquiry Learning) classrooms, students in learning teams actively engage with materials using carefully designed activities, facilitated by the instructor. By closely scrutinizing data, graphs, instrument schematics, or other models and answering guiding questions, students are led to generate their own conclusions and construct their own conceptual understanding of analytical chemical principles. This dynamic learning strategy develops student problem solving, critical thinking, teamwork, and communication skills in the context of six fundamental areas of analytical chemistry: spectrometry, separations, equilibrium, electrochemistry, statistics and analytical tools. A sampling of ANAPOGIL materials will be presented, along with classroom implementation and assessment strategies.

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INQUIRY-BASED SCIENCE EDUCATION IN MALAYSIA: ISSUES AND CHALLENGES

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Like many countries in Europe and the Americas, Malaysia is also beginning to explore the introduction of Inquiry-based science education (IBSE) in schools.

In order to prepare students for the demand of twenty-first century, science education is aimed at enabling students to understand fundamental scientific ideas which prepare them to understand events and phenomena of relevance in their current and future lives. It should also aim to prepare students to understand how scientific ideas and knowledge are obtained and to enable them to develop the skills and altitudes involved in seeking and using evidence. An inquiry approach to science education, or IBSE, is widely viewed as being capable of achieving these aims to a far greater degree than traditional approaches. This explains the move into IBSE in schools in many developed as well as developing countries.

Many countries including Malaysia are also faced with a declining interest in science among the school children. It is believed that with an inquiry-based approach, science education could be made more attractive and liked by these children.

However, in introducing IBSE in schools, we are faced with many issues and challenges. First, the current curriculum content has to be changed to make it more relevant to science in everyday life and the students' interest. The pedagogy of science education has also to be realigned towards an inquiry approach. Teacher training and education have also to be adjusted. On top of these is the testing and assessment of IBSE. This paper proposes to discuss some of these issues and challenges faced by the introduction of IBSE in Malaysian schools.

SYSTEMIC THINKING APPROACH TO TEACHING AND LEARNING CHEMISTRY

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The core objectives of chemistry as a science is to study the matter and energy, its reactions and interactions, its structure and behavior, its positive and negative impact on our environment. Although any human brain works systemically, the brain of chemists should be working super systemically due to the nature of chemistry as a central science related systemically to other sciences, and to our daily life in which everything is systemic.

Atwater & pittman (2006) reported that scientists live in a systemic age. So, systemic thinking approach to teaching and learning chemistry [S.Th.A.T.L.C] is the motive force for dealing with chemistry in the systemic age.

The present article aims to Understanding the systemic thinking-approach: definition, perspective, its language, skills and tools. Systemic thinking approach is a light mental cognitive process characterized by: holistic, dynamic, interconnectivities and multiple feedbacks.

1) Systemic thinking perspective are;
   a) Looking for mutual interconnections between system elements,
   b) Holistic and dynamic vision for changing processes.
2) Systemic thinking language are;
   a) Reinforcing feedback loop,
   b) Balance feedback loop.
3) Systemic thinking tools are;
   a) Observing the behavior of the system over time,
   b) Drawing causal loop diagrams,
   c) Analyzing and synthesizing in systemic context.
4) Systemic thinking skills are;
   a) Dynamic,
   b) System as-cause,
   c) Forest or generic,
   d) Operational,
   e) Using closed loop skill.

The systemic thinking approach to teaching and learning chemistry [S.Th.A.T.L.C] can include:

1) Systemic insights into complex chemistry problems.
2) Enhancement of syntheses of pharmaceuticals and chemicals by make use of systemic modeling programs instead of linear programming to find creative models for synthetic strategies.
3) Determine systemic chemical processes which reinforce each other, from one hand, and those that make balance among them for the other hand.
4) Teaching and learning chemistry should be organized as interconnections between: systems and subsystems

THE SYSTEMIC APPROACH IN TEACHING AND LEARNING MEDICAL BIOCHEMISTRY

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SALTC is a method that gave a global vision to teaching and learning chemistry. This method will also be used in every aspect of the modern human life.

The strategy of this method is based on the collection, organization and presentation of the map of concepts through the interactive system in the course of which the relations between the concepts and issues with be clarified.

The main structural element of the SATLC method is the systemic diagram which has all the attributes of a closed map of the concept.

The systemic diagram is created on the basis of the combination of the knowledge that students already have and that they gained through the study of the modules.

The construction of systemic diagram helps students to understand the conceptual basis of the subject.

During the application of this method, besides concepts, principles and various metabolic procedures that occur in the organism, students will also learn to understand why biochemistry is very important in medicine and how the biochemistry principles are involved in everyday professional practice. There are many application examples of biochemistry principles. Krebs cycle is a biochemistry concept. How it works in the alcohol is a health –related application. Glycolysis is a principle. Its role in the diabetic is the problem.

In this article, I will present the application of SATLC method in the subject of medical biochemistry.

Keywords: SATLC , systemic diagram, water, function, digestion, human metabolism.

SATL MODEL LESSON IN CHEMICAL KINETICS

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Studies in order to pursue kinetics and mechanism of chemical reactions are a vital component of chemical literature. SATL literature is still not available for promoting this vital aspect of chemistry teaching. A lesson pertaining to this important issue has been developed and various parameters of kinetic studies are explained therein. An illustration is as follows:

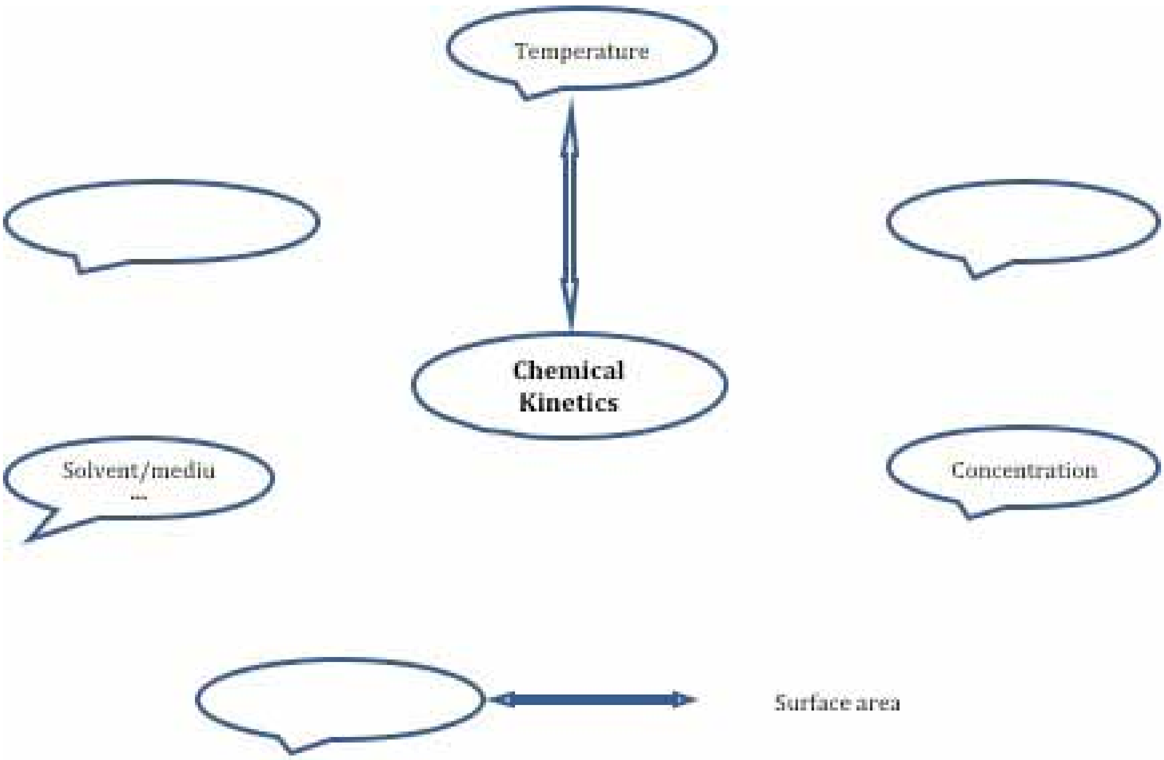

Figure 1: Different parameters of Chemical Kinetics.

ONTOLOGICAL REPRESENTATIONS IN SOLVING STOICHIOMETRY PROBLEMS IN CHEMISTRY EDUCATION

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This paper gives a survey of ontologies used for the representation of stoichiometry problems and their solutions. This approach to knowledge representation uses real maps of knowledge in the form of modified graphs that reflect the structure of certain scientific and educational content. Following the Systemic Approach to the Teaching and Learning Chemistry (SALTC), which was based by Fahmy and Lagowski in 1997th [1,2], we created systemics for one chemistry teaching unit-Stoichiometry.

Stoichiometry is regarded as one of the fundamental "tools in the chemistry toolbox" [3], and stoichiometry problems are one of the most frequent problem tasks in chemistry education, which can be designed in a high range of problem situations. In stoichiometry we can define two types of quantitative problem tasks. First group contains basic problem tasks, and for their solutions we need less steps. Second group contains complex problem tasks whose solutions require more steps. This kind of tasks usually contains more basic problems, which are related to each other [4]. In this paper we give examples for both types, applying systemics in solving tasks based on shown chemical formula and chemical reaction.

On the other hand, one of the main goals of learning and training in the global chemistry education is development of effective methods and strategies used to create a system of scientific chemical knowledge. Systemic arrangement of important concepts and conclusions in a system in which the connections among concepts and conclusions are made clear [5], allows the realization of qualitative knowledge, facilitates teachers' time articulation of classes and successful transfer of knowledge to students.

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DEVELOPING PROFESSIONAL TEACHING COMPETENCIES OF CHEMISTRY PROFESSORS

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Abstract: This paper presents the results of implementing a professional training proposal for chemistry professors of based on developing their professional teaching competencies.

In order to consider the basics of professor professionalism in systemic and holistic terms, we must necessarily ponder the various areas of social and cultural interaction where professor competencies are acquired and become meaningful, namely interaction with their knowledge of their subject, of themselves and the other parties involved in education and a greater context.

Keywords: Professional teaching competencies, Professional development of chemistry professors.

Method:

Step1. Diagnosis: a) Literature review (studies on the scientific and didactic conceptions of chemistry professors); b) Chemistry professors' perceptions on their professional teaching competencies and their training needs. (n= 65 chemistry professors).

Steps 2-3. Design and implementation of a systemic and holistic training proposal: Based on the results of diagnosis, we prepared and implemented a training proposal that is not confined to one sole teacher training strategy, but incorporates the contributions of various trends to add to integral professional teacher training: a) teacher learning in professional development communities; b) teacher as researcher; c) The teacher's role in inquiry-based learning and problem-based learning; d) Professional Development through reflection and metacognitive strategies; e) Teacher's in-depth pedagogical content knowledge and subject matter didactics.

Results and Discussion: Since the 80's decade, less than 2% of the papers correspond to specific studies on the scientific and didactic conceptions of chemistry professors.

The results indicate that this training proposal facilitate teachers' understandings about inquiry-based teaching in the classroom, and improve the development of teachers' ability to ask inquiry questions and a desire to actively use these questions for planning learning activities appropriate to guide their students in problem solving. The chemistry professors also reflected on their experiences during the design and implementation of real innovative educational projects and engaged in self-assessment opportunities by sharing success and challenges in implementing their learning activities.

COHERENCE IN KNOWLEDGE INTEGRATION IN BIOCHEMISTRY

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Coherent knowledge integration is a key factor for the development of expertise. Traditional concept-driven and compartmentalized education has contributed to a disintegrated, and fragmented understanding of the core theories and concepts of basic and natural sciences. Biochemistry, at the interface of chemistry and biology, has proven to be a particular difficult subject as it requires the application of pre-acquired concepts of both disciplines to new biological contexts, in an integrated and interconnected way [1]. Research on undergraduate students learning of biochemistry and life sciences reveal that those with disintegrated and fragmented cognitive understanding of chemistry and biology concepts tend to follow a "surface" learning approach in biochemistry (with high focus on memorization and rote learning) [2]. Biochemistry education is greatly challenged by the selection of content [3], by students' reasoning difficulties with different organizational levels in complex systems [4], and by students' difficulties regarding the visualization and interpretation of multiple external representations [5]. These challenges will impact learning in biochemistry.

The present study aims at understanding how coherence in knowledge integration in biochemistry is constructed, by interviewing experts and novices, and following tutorial conversations between them around diagrams/concept maps that depict the core concepts of their respective fields. The theoretical framework supporting this study is based on micro-macro thinking [6,7] and concept mapping [8]. Preliminary results will be presented and discussed. Results are expected to provide useful information to support curriculum and educational design.

This study is a collaboration with Dr. Stefan Rudiger and Professor Ineke Braakman from the Department of Chemistry of the University of Utrecht.

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STRATEGIES PLUS MOTIVATION: A SYSTEMIC APPROACH TO THE LEARNING OF CHEMISTRY

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Meaningful problem solving is an important goal of tertiary education. Unfortunately, many of my students seem to believe that this activity does not deserve too much effort and they develop the attitude that arriving at the answer is more important than understanding the process of solution. While they are very clever in applying formulas, they have troubles in meaningful problem solving, when it is necessary to represent the problems, and then, having analysed them, to plan a method for their solution.

For example, a Friedel-Maloney questionnaire[1] proposed during first lessons for students enrolled in the first year of an engineering university course typically leads to poor results (less than 50% correct on any question). Only 10 students out of 75 solved correctly the four questions, while 24 got all four questions wrong. Glaser and Chi[2] enumerate seven characteristics of experts, but the difference which is of major importance for the novice, is that the expert spends a great deal of time analysing a problem qualitatively. If we want to help our students, we have to find a different way to teach problem solving, a way that obliges students to spend more time analysing the problem. The initial problems tackled were non-chemical and non-algorithmic to emphasize the analysis and synthesis operations without the interference of chemical concepts which some students may not know.

According to the Shulman's Table of Learning[3], the first step is: engagement and motivation. To engage and motivate them, a cooperative learning approach was used and to help students organize and structure their knowledge, they were asked to draw a concept map or write a resume for each topic presented in the course. Constructing the solution in the group, negotiating the meaning, explaining inferences, teaching one another, and making sense of the relationships facilitates the deep understanding of the solution. Our students need some tools to tackle the problems in a methodical manner, so over the years many useful strategies have been developed. Strategies are mental tools that help to develop the correct reasoning while solving new problems. And the emphasis is on the reasoning. These thinking frames can help students become better and more successful thinkers.

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STUDENT BELIEFS ABOUT SCHOOL-BASED ASSESSMENT OF CHEMISTRY PRACTICAL SKILLS

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Laboratory work is an important component of school chemistry. However, over the past four decades there has been considerable debate about how assessment of student practical skills should be conducted as part of the public examination.[1-2] In 1978, coursework assessment of laboratory work was introduced for the Hong Kong advanced level chemistry examination.[3] Recently, a new chemistry curriculum for Secondary 4 - 6 students (aged about 16 – 18) was implemented in 2009 and a new coursework assessment scheme called School-Based Assessment (SBA) was introduced. The Hong Kong Examinations and Assessment Authority has allocated 20% of total marks to the SBA and required teachers to make at least eight assessments. Owing to large class size and time constraints, some teachers have complained about the need to conduct SBA in their chemistry course. In the UK, coursework is preferred to examinations by most students, but the reliability of teacher assessment is still a major concern.[4-5] Researchers have not systematically investigated Hong Kong chemistry students' beliefs about the new SBA scheme. In this paper, I report how interview and questionnaire data were collected from 120 chemistry students. Results from my study indicated that many students believed that SBA is valuable and should not be cancelled. It can provide them with opportunities to apply what they have learned in theory lessons. Students also believed that teachers are the best persons to assess their performance in practical work. However, many students did not believe that the SBA should be expanded to cover assessment of other practical work such as design of posters. The implications of these findings for implementation of SBA in school are discussed.

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ASSESSING STUDENT ACHIEVEMENT WITH A PROCESS-MODEL OF EXPERIMENTATION

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Current education standards for science teaching underline the importance of experimentation as a method for solving scientific problems (e.g., NRC, 1996). The integral part experimentation has played in the science classroom since the 19th century (Lunetta, 1998) receives renewed interest from science education researchers and practitioners because of this. Since the process-aspects of experimentation come into the focus of instruction the need arises for an aligned assessment (cf. Baxter & Shavelson, 1994). Although there are obvious parallels in suggestions of how experimentation processes might be structured, no assessment tool has been suggested to capture students' achievement in this process, yet. Therefore, the proposed study started from assuming a basal, not exclusive process-model of experimentation that can be considered a consensus from multiple approaches (cf. Emden, 2011): (1) finding an idea/hypothesis, (2) planning and conducting an experiment, (3) drawing conclusions from evidence. The study confronted 339 students (M=11.51 years, 45.7% female) with three open inquiry tasks on three days, which took the form of scientific problems that did not provide predefined solution paths but encouraged students to negotiate their experimentation in working groups. Due to the offered array of experimental equipment, there were usually multiple solutions possible for each task. Selected working groups were videotaped while experimenting (n=98 videos). All the students were asked to report what they were doing in a structured report-form while experimenting. The report form differentiated between the three steps mentioned above and students were frequently reminded to fill in the form. The generated videos and reports (n=476) were analysed in a two-stepped way: (1) Experimentation processes were coded into schematic process graphs and on basis of these (2) performance scores were calculated accounting for the logical coherence and directness of the individual solution paths. Correlative analyses showed for two of the experiments that the report format yielded comparable performance scores to those gained from actual experimentation in the videos (r_S>.80). A first suggestion of a suited process-oriented assessment tool for experimentation can be drawn from this study and thus complements process-oriented science instruction, thereby honouring the epistemological potentials of student experimentation.

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MATHEMATICAL MODELLING IN CHEMISTRY LESSONS

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It is often necessary to apply mathematical terms, methods and scientific paradigms in order to explain chemical phenomena by interpreting mathematical formulations in terms of content. Considering the acquisition of problem solving competences in chemistry, it seems to be reasonable to introduce tasks which aim at problem solving by using mathematical models: Mathematical modelling in chemistry lessons demands the transfer and usage of mathematical knowledge in new and significant situations and thus can support the comprehension of the modulating terms and foster problem solving skills. However, it is known that students have difficulties with connecting aspects of mathematics and chemistry [1]. But problems with mathematical modelling in chemistry lessons have not been examined, classified or even solved yet. Moreover, it is still unclear to what extent mathematical modelling is actually implemented in chemistry lessons at all. In order to identify whether mathematical modelling should be taught in chemistry lessons, the actual German curricula of Upper Secondary Chemistry have been analysed. Furthermore, textbooks and exam questions have been analysed to find out to what extent mathematical modelling is actually implemented in chemistry lessons and which skills are expected to be acquired in this area.

In order to be able to classify students' difficulties with mathematical modelling, the modelling process has to be described in a detailed way [2]. By doing so, it is possible to specify at which step students face problems. Tasks with incremental support can be used as diagnostic tool to identify students' difficulties at each step of the process of mathematical modelling.

In the presentation, a detailed description of the process of mathematical modelling adopted for solving chemical problems will be introduced at first. In the following, an insight into the results of the analysis concerning the actual situation of mathematical content in German Upper Secondary Chemistry will be given. Furthermore, an example of a task with incremental support used as diagnostic tool regarding problems with mathematical modelling in chemistry will be shown and finally, first experiences in using such tasks will be presented.

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PROBLEM SOLVING IN THIRD-LEVEL ELECTROCHEMISTRY

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Electrochemistry (EC) constitutes a traditional part of physical chemistry, with one or more electrochemistry chapters featuring in most physical chemistry textbooks. Educational research has shown that many of the problems associated with the learning and teaching of EC are caused at earlier stages of education (De Jong & Treagust, 2003). In this work, exploiting the fact that one of the authors (GT) has been teaching the EC course for many years to fourth-semester chemistry students, we have used data from final-semester summative exams to study the students' problem solving ability and their conceptual difficulties in equilibrium EC.

Method. Data from seven examinations papers were used. There were two kinds of questions in each paper: (i) straightforward knowledge questions, (ii) more demanding questions that required application of knowledge to problem solving. Only questions of type (ii) are of interest in this work; also only successful papers were taken into account. We consider here four problems that involve the application of the Nernst equation, and which were given at various exams.

Results. From 314 papers, 204 (65.0%) passed the EC part, while 149 students (47.5%) were successful in predicting the spontaneous reaction and calculating the ΔE^o value for a reaction from the E^os for the corresponding half reactions. Smaller (33.5%) was the percentage of the same students who applied correctly the Nernst equation for solving a galvanic cell problem. Regarding the students' errors and conceptual difficulties, in a total of 137 successful papers, the mean mark in EC was 60.1% (standard deviation 16.0%). Only 37.2% of the students dealt correctly with the problem, while 13.1% did not attempt the problem. 32.8% calculated correctly the absolute value of ΔE^o, but they took the wrong sign for it; and 13.1% failed to assume that at equilibrium $\Delta E^o = 0$. Smaller (less than 10%) percentages of students: didn't know one or both half reactions; failed to properly balance a redox half reaction; ignored that $\Delta E^o = E^o_{reduction} - E^o_{oxidation}$; failed to apply correctly the Nernst Equation; mixed the American and European sign conventions for the redox potentials.

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USE OF PROBLEM SOLVING TO ELICIT SELF-EXPLAINING IN GENERAL CHEMISTRY

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The prevalent trend in chemistry instruction relies on what Lemke (1990) described as *the classroom game* which posits students in a passive role. In this model, the instructor does all the explaining (thinking), and learning is trivialized to knowing the correct answers (memorizing) and being able to produce them when prompted (regurgitating). This kind of instruction perpetuates the reductive view of science as a collection of facts and does not promote "*understanding chemistry as a way of thinking"* (Talanquer & Pollard, 2010). Research findings in educational psychology have shown that implementing activities that elicit self-explaining improves learning (Chi, De Leeuw, Chiu, & LaVancher, 1994) and enhance authentic learning in the sciences (Chi, 2000; Songer & Gotwals, 2012). Self-explaining refers to the student's generation of inferences about causal connections between objects and events. In science this may be summarized as making sense of *how* and *why* actual or hypothetical phenomena take place. Research suggests that self-explaining influences many aspects of cognition, including acquisition of problem-solving skills, and conceptual understanding (Siegler & Lin, 2009). Also, the act of self explaining by its very nature requires the reader to be aware of the comprehension process, influencing metacognition as well (McNamara & Magliano, 2009). Although, there is clear evidence for the link between self-explaining and learning, there is a need for research conducted in the context of real college science learning environments. This study intends to fill that void by studying the effect of different self-explaining tasks on learning chemistry concepts. The conditions used in this study include: solving problems without explaining, explaining correct and incorrect answers, explaining agreement with others' answer, and explaining one's own answer for others to use. These conditions are observed in the naturalistic classroom ecology of a large enrollment general chemistry course. Preliminary results and ongoing work will be discussed.

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CHEMICAL PRODUCT TECHNOLOGY: EMBEDDING CHEMISTRY INTO RESEARCH AND DESIGN AT ACADEMIC LEVEL

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Chemical Product Technology is a new emerging paradigm among (at least so far) chemical engineering disciplines. Already started in the mid 1990's, the development of the chemical product technology curriculum is far from established[1]. The core of this new discipline consists in the design of new (or improved) chemical products together with the corresponding production process[2]. As such, Product Technology (PT) is characterized by a prominent multidisciplinary character since it combines different disciplines for the aim outlined above. In particular, PT contains relevant chemical aspects in the corresponding research themes as well as in the corresponding educational programs (e.g. Master studies) at academic level. Furthermore, the combination of more "research-driven" aspects together with "design-based" ones constitutes also a prominent novelty of this discipline. In the present work we intend to discuss the underlying elements of this combination, namely the approach to knowledge generation ("research-driven" stage) as functional for the "design-based" stage. We will illustrate this on the basis of a lecture series, currently used in one of our Master courses for Product Technology at the University of Groningen. The focus will predominantly lay in the definition and use of general academic skills, and the way in which these are taught to the students. Such general concepts will be framed in a practical example (the use of compatibilizers in polymer blends), part of our PhD and undergraduate research program.

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CHANGING CAREERS IN CHEMISTRY

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The contemporary chemical industry is fully embedded in society, whereas academic chemistry in its maturity is described as increasingly incurious and risk-adverse [1]. For the future chemistry's best intellectual properties are located outside its historical boundaries. This requires changes in chemistry's course-work, even the inclusion of 'non-science' subjects in order to prepare our graduates for the job market [2]. However, the curriculum at most traditional Western universities does not necessarily reflect these new dynamics.

The European Technology Platform on Sustainable Chemistry "Suschem" analyzed a potential skills shortage and indicated that already two thirds of European chemical companies had difficulties in filling vacancies. Some shortages arise from a mismatch between the requirements of industry and taught courses. It is not sufficient saying "we need more chemists": we need to be specific and look at precise skills and shortages, these are different things.

The main abilities and competences that students are expected to have developed by the end of their program are usually subdivided into chemistry-related cognitive abilities and competences, chemistry-related practical skills and generic competences. A more recent alternative subdivides into scientific competence, soft skills and entrepreneurial skills [3].

Entrepreneurial skills cannot be developed at a Higher Education Institution, this is the usual response when the training of entrepreneurial skills is demanded. A recent inquiry asked for scores for entrepreneurial skills of graduates in analytical chemistry. The inquiry specified several constituents of entrepreneurial skills. Some rather basic abilities obtained inferior scores. It becomes clear that several entrepreneurial skills can well be trained during common chemistry programs. Conclusions for chemistry education will be discussed.

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A HYPOTHETICAL LEARNING PROGRESSION IN TERMS OF IMPLICIT ASSUMPTIONS MADE BY LEARNERS ABOUT BENEFITS, COSTS AND RISKS IN CHEMICAL DESIGN

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The central practice of chemists is to design chemicals. The design of chemicals involves weighing and optimizing tradeoffs among the benefits, costs, and risks of the substances being designed and the methods necessary to produce them. While traditional undergraduate chemistry preparation focuses little attention on thinking processes associated with this practice, modern chemistry demands that chemists graduating from university be adept at this. The design, implementation, and assessment of instructional materials by chemistry instructors to meet this demand can be strengthened by having a learning progression describing how students develop understanding of benefits, costs, and risks in chemical design.

Our project focuses on the development of a hypothetical learning progression on benefits, costs and risks in chemical design, characterizing progress in student understanding in terms of changes in the implicit assumptions that learners make[1] as they reason about the design of chemical products. The development of this learning progression involves review and analysis of existing research studies on how both laypersons and scientists assess risk, analyze costs, and perceive benefits to hypothesize the implicit assumptions that constrain reasoning. Then, taking the hypothesized assumptions as a first approximation, students are interviewed using generative questions based in current research, e.g., the study of hydrofluorinated ethers as chlorofluorocarbon replacement compounds[2, 3], that cause them to express mental models that are constrained by the implicit assumptions they make about the properties and behavior of the system under analysis. These mental models, which blend experientially derived knowledge and academically learned ideas, can be probed through individual interviews that help uncover underlying assumptions, providing a feedback loop that allows for iteratively improving the characterization of student reasoning. Based on interviews with students across all levels of undergraduate chemistry courses, a hypothetical learning progression can be developed that provides a conjecture of likely pathways through increasingly sophisticated ways of reasoning. The process of developing this hypothetical learning progression will be described.

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BRIDGING GAPS BETWEEN RESEARCH AND EDUCATION: THE NANOLAB „KLICK!“

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Is it possible to offer school students and (student) teachers insights into “high end research”? What would be the preconditions and the expected effects of such initiatives?

The NanoLab “Klick!” for students and teachers aims at finding answers to these questions. It is connected to the Collaborative Research Program “Function by Switching” (funded by the German Research Foundation DFG) and currently develops several educational and public out-reach activities. Those should be the basis for further educational research on the students´ and teachers´ learning and the public understanding of science.

The outreach and education project defines three areas for the development of knowledge, interests and attitudes/beliefs: (1) What are the specific characteristics of the “Nano world”? (2) What are interesting fields for the application of nano technologies and research findings? (3) Which specific methods of research are applied to gather knowledge about things we cannot see?

In a first step, existing material has been analysed according to their goals, their quality (e.g. of lab experiments or simulations) and their possible implementation into the project program. This has led to a conceptual design for an out-of-school learning environment for secondary school students and teacher training: the NanoLab “Klick!”. The educational goals of this learning environment are not only to introduce the participants to the fascinating world of “Nano”, but also

- to enlarge their perspectives on structure-property-relations by focusing on effects such as size and scale [e.g. 1];
- to combine experiments and simulations according to Johnstone´s triangle [2] to enhance the students´ thinking as connections of phenomena and models and
- to offer insights into scientists´ working areas and their personal characteristics [e.g. 3].

The NanoLab activities will be offered to secondary school students and to (student) teachers. To get first insights into the achievement of the goals mentioned above, participants will be interviewed after exemplary chosen activities. Based on the results, the activities will be optimised and further instruments for accompanying research studies will be developed.

The conference presentation will highlight the conceptual approach and exemplary material, and will also discuss first data from the piloting interviews.

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TAUTOMERISM AND CHALCOGEN EFFECT OF 1-HYDROXYPYRIDIN-2-ONE: COMPUTATIONAL CHEMISTRY AS A TOOL TO ENHANCE LEARNING

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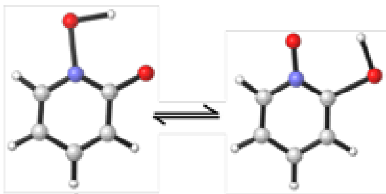
Computational chemistry has emerged as a discipline that conjoins observation, experimentation and theoretical aspects of chemistry. It equips students with a toolset that is as important to acquire as the skills in a traditional "wet" laboratory. For students, it is important to not only understand how to use computational chemistry tools to solve chemistry challenges, but also to understand computational methods. Teaching tautomerism is challenging as the mechanistic aspect is not easily visualized and transition state structures are complex. We have used computational chemistry to explain concepts involved in the interconversion of tautomers of 1-hydroxypyridin-2-one.[1-5] The latter exists as two conformers, **1** and **2**, in equilibrium.



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In this project, the tautomers of 1-hydroxypyridin-2-one and their chalcogen derivatives (S and Se) were studied in gas phase. The transition states for the interconversion of the tautomers were also modeled. All the tautomers were fully optimized using DFT method and the B3LYP functional. For all atoms, the 6-31+G(d,p) basis set was used. Frequency computation for all structures was carried out to confirm the nature of the stationary points. Optimized molecular structures and related structural parameters of the tautomers were predicted. The energy differences, associated rotational barriers and thermodynamic parameters were derived from the computations. The results obtained were analyzed, discussed and compared to understand the chalcogen effect. A pedagogical outcome of this project is that the learning of tautomerism can be enhanced using computational chemistry.

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FROM BEAKER TO COMPUTER: COMPUTATIONAL CHEMISTRY INTEGRATING TEACHING AND RESEARCH

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Chemistry is one of the subjects of Science for understanding and explaining makeup and changes of everything that has mass and occupies space. Humankind's understanding of the material nature of our world depends on our knowledge of chemistry. Chemistry relies on experiments and systematic observations. However computational chemistry, an emerging field, uses principles of computer science to assist in solving chemical problems. Computational chemistry is integrating the chemistry curriculum and is being used effectively in research. Since the year 2000, a computational chemistry module is being offered as part of the chemisty programme at the University of Mauritius. This talk relates to the expereience and development of computational chemistry at both teaching and research levels. The training of the students and the areas of research of the computational chemistry group namely novel species, global warming, reaction mechanism and drug development are elaborated.

USE OF THE ON-LINE GRADED HOMEWORK SYSTEM MASTERINGCHEMISTRY TO IMPROVE AND ASSESS STUDENT WORK ETHIC, METACOGNITION, AND PERFORMANCE IN A FIRST-YEAR UNIVERSITY GENERAL CHEMISTRY COURSE

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Inexpensive, commercially available computer-based tools[1] provide effective ways to improve chemical education and assess results of pedagogical changes made by the instructor. This paper describes how the on-line graded homework system MasteringChemistry can be used to affect changes in student study habits, enhance student awareness of their understanding of specific learning outcomes, and improve student retention of material. Facile assessment of pedagogical changes over a four-year period will be demonstrated.

For several years prior to 2007 first-year students in a general chemistry course for science majors were perceived as becoming increasingly passive and irresponsible learners due a lack of a challenging secondary school environment, which had a negative effect on the ability of these students to perform satisfactorily at a tertiary level. It was hypothesized that a properly used, well-designed, on-line graded homework system used in conjunction with a demanding course would have a positive impact on student study attitude[2] and improve content mastery as measured by average class scores on standardized examinations and students identifying the on-line graded homework system as the most positive influence on their success in the course.

MasteringChemistry features found to be particularly effective include: 1) 24/7 accessibility; 2) multiple textbook correlation; 3) number, type, and difficulty range of problems; 4) tutorial problems with Socratic feedback; 5) algorithmic problems; 6) units feature that requires proper unit as well as numerical answers; 7) international database that gives student time on task and problem level of difficulty based on a student use/performance algorithm; 8) flexible assignment and grading control; 9) formative student and assignment assessment tools that allow comparison to the international database; 10) outcomes analysis of specific and global skills.

When compared to a 2006-2007 baseline class that did not use MasteringChemistry, the 2007-2008 average class performance on the American Chemical Society Examination in General Chemistry increased 2 percentile points among one-semester and 7 percentile points among two-semester MasteringChemistry users. Changes in hint use grading in 2008-2009 resulted in another 7-percentile point increase in standardized exam score. In 2009-2010 a metacognition exercise requirement raised the average exam score by another 2 percentile points.

Among 20 factors that were suggested to students as possibly having a positive impact on student performance, students overwhelmingly chose MasteringChemistry as the primary factor in their success in the course. Anecdotal student comments support the use of this on-line graded homework system as having a significant influence in improving student study skills.

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IMPLEMENTATION AND ASSESSMENT OF COGNITIVE LOAD THEORY (CLT) BASED QUESTIONS IN AN ELECTRONIC HOMEWORK AND TESTING SYSTEM

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Cognitive Load Theory (CLT) attempts to minimize short-term memory load while maximizing the memory available for transferring knowledge from short-term to long-term memory. Our implementation of CLT components into the JExam electronic homework system attempts to minimize intrinsic and extraneous load by breaking down multistep problems into smaller, individual steps for the students. Using the static fading approach over several questions, students weave all the steps together to solve the entire problem. Using Item Response Theory abilities, we compared student performance utilizing CLT static fading approach to that of students without the CLT components. On seven out of eight topics, students exposed to CLT component homework questions scored higher on subsequent test questions related to that topic than those not exposed to CLT. In four out of the eight cases, students exposed to CLT based homework questions improved their chances of correctly answering related test questions by greater than 10%.

CYBER POGIL: ENHANCED ACTIVE LEARNING SCENARIOS THROUGH WEB-BASED COLLABORATION

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The objective of this study was to analyze the effectiveness of three teaching strategies in high school chemistry and biology classrooms: traditional group instruction, POGIL (Process Oriented Guided Inquiry Learning), and POGIL combined with Ubiquitous Presenter (UP), a web based collaboration application. The focus of the study was on understanding the interactions between the students, the learning gains, and the students' perceptions of each method. Qualitative and quantitative data were gathered using group and whole class discussions, surveys, and students' submissions from the UP logs. Statistical tests were run for quantitave data and in-depth analysis of the qualitative data was completed. After working in all three styles, most students reported that they preferred working with POGIL and the UP versus POGIL alone, or traditional lectures. Collaborating on their group's submissions and the ease of revising the submissions encouraged cooperation among students while discussing, refining, and rethinking their answers.

ONLINE WEB LEARNING IMPROVES FINAL GRADES IN ORGANIC CHEMISTRY

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To improve student performance and grades, Wageningen University introduced Online Web Learning (OWL) in Organic Chemistry courses three years ago. Cengage Learning offers OWL packaged with the chemistry textbooks of McMurry. OWL includes an eBook integrated with several types of homework exercises. *Mastery Learning Problems* contain questions associated with specific concepts or skills. Problems are presented randomized and students receive detailed feedback which allows them to keep on practicing until they understand the underlying chemical concepts. *Simulations* are designed to aid conceptual understanding of chemical systems. These contain an interactive panel where students adjust variables in a system, observe the resulting changes to the system, and answer a set of guiding questions that lead the student through an exploration of the concept. *Tutorials* lead a student through a problem, showing them how to solve it step-by-step. Tutorial help is offered for each step in the process. *Visual Exercises* contain interactive versions of figures from the text and a set of guiding questions that lead the student through an exploration of the concept illustrated in the figure. *End-of-chapter* questions contain interactive versions of the textbook's end-of-chapter questions and often include step-by-step tutoring on how to solve the problem. OWL for Organic Chemistry contains the JMOL applet allowing students interactive viewing of molecules and Marvin Sketch software for drawing molecules.

The first year we introduced OWL, students took part voluntarily which resulted in a very low participation of 10%. For this reason, we made OWL part of the exam and participation increased to 95%. About 1000 students have been using OWL at Wageningen University in several Organic Chemistry courses, last two years. OWL was evaluated by the students and a large majority was very enthusiastic about it. They said that it really helped them understanding the chemistry and because every exercise had a deadline they were forced to keep up with the subject material. It was very clear that students who used OWL were more likely to do their homework than those who took the course prior to the introduction of OWL. There was also found a significant correlation between homework scores in OWL and the final grade students received in the class.

ORGANIC CHEMISTRY FLASHWARE 2.0 - A PREVIEW

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Organic Chemistry Flashware (OCF) began as a collection of 135 interactive web-based animations for teaching and learning organic chemistry, emphasizing the arrow-pushing notation, resonance, reaction mechanisms, and localized orbital interactions. Optimized for both classroom projection and individual usage, Organic Chemistry Flashware enhances the traditional lecture experience while providing students with a rich environment for individual study. Animated reaction mechanisms present the arrow-pushing notation in visual fashion where lone pairs literally morph into bonds (and *vice versa*). Kinematics of dash/wedge line structures during reaction mechanisms help students to "*Think Tetrahedral*". All reaction mechanisms can also be viewed as fully annotated animations of their relevant localized molecular orbital interactions, a pedagogical first. A preview of OCF 2.0 comprising over 220 animations will be presented, including new sections on stereochemistry, conformational analysis and NMR.

WAYS OF DIAGNOSING AND FOSTERING JUDGEMENT-COMPETENCE

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In the course of PISA 2000, judgement-competence were introduced to the German national standards for lower secondary Chemistry as well as to the core curricula of the federal states of Germany with different priorities [1,2]. Judgement-competence have been discussed since the 1970s until today and are now to be addressed in school so that pupils get the opportunity to learn how to make well-founded judgements and decisions. That means, that they should be able to identify arguments, to understand the reasons which lead to a decision, and to come to an own decision based on adequate motives [3]. In chemistry lessons, pupils should learn to consider and judge the chances and risks of chemical developments and processes and to decide on different possible actions in chemical contexts [4]. But: "Among all competences included in the standards of education, "judgement-competence" seems to be the one, which is most difficult to interpret." [5]. This leads to the necessity to develop an instrument to diagnose judgement competence in everyday lessons to help teachers to diagnose the judgement-competence their pupils and to re-arrange their teaching. Such an instrument can subsequently then be used to evaluate ways of fostering judgement competence, especially cooperative-forms of learning and the use of ICT-based interactive response systems.

The research questions underlying this project are: 1. How to develop a tool to analyse pupils' actual judgement-competence as impartially as possible in everyday lessons of lower secondary education without responding to ethical and moral aspects? 2. How is facilitating judgement-competence by means of cooperative forms of learning possible with the special focus on the use of ICT-based interactive response systems, with which one can easily get a picture of the pupils' actual opinions?

In order to answer these questions, an instrument, which is currently tested, has been developed to measure certain aspects of judgement-competence in everyday lessons. This instrument consists among other things of a comic with gasp and a description of a scenario.

In the presentation, the designed diagnosis instrument will be put up for discussion, the first experiences from a pilot study with more than 100 pupils with its application will be presented and the use of response systems in the context of teaching and diagnosing judgement-competence will be shown.

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A QUALITATIVE STUDY INFORMING THE DESIGN OF AN ELECTRONIC LEARNING TOOL SHOWCASING AN ATOMIC LEVEL VIEW OF SUBSTANCES UNDERGOING CONDUCTION

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Many General Chemistry courses include a laboratory experiment that allows students to explore the conductivities of solutions that contain strong electrolytes, weak electrolytes and non-electrolytes. Conductivity testing provides the student with insight into the atomic level of solutions by revealing the degree to which mobile ions exist in the solution. Typically, the student learns to write a symbolic representation that distinguishes strong electrolytes from weak electrolytes and non-electrolytes. Unfortunately, while many students find it easy to test the conductivity of solutions, they may have incorrect conceptions about the atomic nature of the solutions and how that relates to their symbolic representation. The goal of this qualitative study was to examine the kinds of atomic level features expert chemistry instructors wanted their best General Chemistry students to convey about the following items: Strong acid (HCl), solid sodium chloride, aqueous sodium chloride and weak acid (acetic acid). In addition, the experts were asked how they wanted these students to represent the atomic nature of the same substances being tested for conductivity. After the experts were studied, first semester, college level, General Chemistry students were asked to construct their understanding of the same substances in their natural state and after being introduced to a conductivity tester. The results of this study were used to design an electronic learning tool (Figure 1) on conductivity to best depict the complexity of the event and to directly address students' misconceptions. The nature of the tool will be demonstrated.

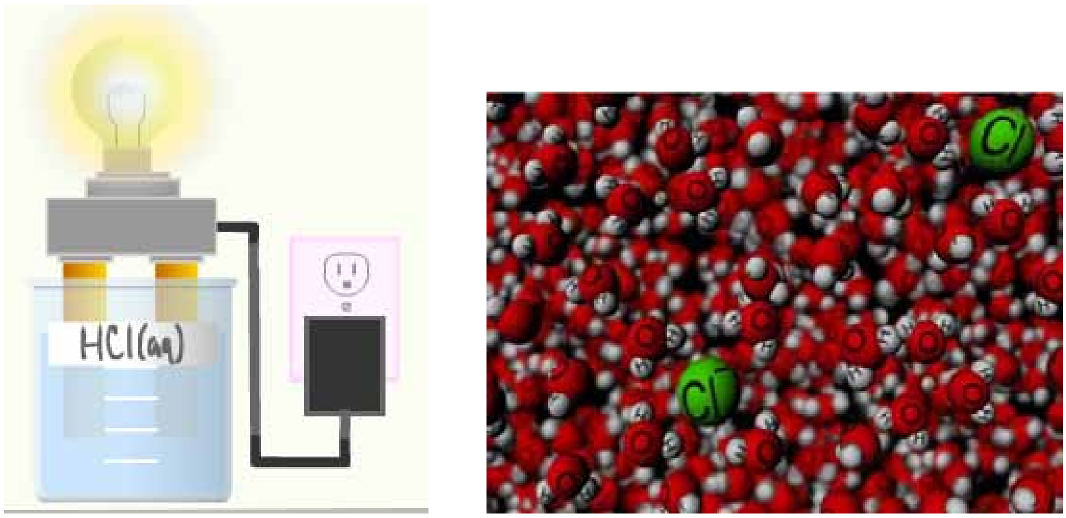

Figure 1. A still image from a macroscopic flash animation showcasing the conductivity of aqueous hydrochloric acid and a still image from a Maya animation showing the atomic nature of an aqueous solution of hydrochloric acid.

THE DEVELOPMENT OF CHEMISTRY EDUCATION IN BALTIC STATES

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All three Baltic States – Estonia, Latvia and Lithuania – have the same longtime historical background in the system of former USSR that emphasizes the development of the educational system in these countries up today. In this context obviously the main trends were –content-oriented teaching subjects, subject (teacher)-oriented teaching and learning, and a five-point scale of assessment of knowledge and skills in Estonia.

Differences in the development of chemistry education we can see only after independence since the 90s of the last century. Now we can see the similarities as well as differences in development of chemistry education in these countries. In this paper (presentation) we will consider similarities and differences in administration and management of chemistry education, financing, competencies-based chemistry education in Estonia and Lithuania and standards-based chemistry education in Latvia.

From gymnasium, the students are able to choose the profile (social sciences including languages, natural sciences, art, music etc.) in Estonia and Latvia, or subject modules in Lithuania. In all these countries the students can study optional subjects following their interests and abilities. All these countries follow the conception of guided laboratory research using a number of digital means such as sensors, data collectors etc. All countries pay much more attention to formative assessment. If we speak about differences in chemistry education between the Baltic States, then Lithuania emphasizes visualisation, Latvia didactical games and Estonia internet based learning (e-learning). According to the new Estonian paradigm of science education, the goal of education can no longer be the acquisition of content knowledge. Education is moving from a book-based system to one which is internet-based including i-Pad textbooks. The goal of contemporary science education is to develop the skills said to be necessary in the global market-place – creativity, flexibility, initiative and leadership, combined with intellectual abilities to solve problems and make reasoned decisions (Laius, 2011).

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ECOLOGICAL-CHEMICAL EDUCATION FOR THE SUSTAINABLE DEVELOPMENT AS A REFLECTION OF THE NEW WORLD-VIEW

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By the end of the XXth century the world came to the ecological threshold, demanding a radical change of the value-world-view, economical, technological bases of social development.

In the capacity of the strategic solution of this problem, at the end of 1980s the International environmental and development commission suggested a conception of sustainable development. In 1992 at the Organization of the UN environmental and development Conference (Rio de Janeiro) the realization of the conception of a sustainable development action program was approved by most of the countries' leaders, including Russia. In 2005 the European economic commission of the UN accepted the Strategy in the educational field in the interest of sustainable development.

The declaration of the education in the interest of sustainable development Decade by the UN (2005-2014) opens a new stage in the development of ecological education – a stage of the ecological education for sustainable development. The aim of the ecological education on this stage takes into consideration a change of the educational paradigm in general – the passage from the transmission of knowledge and skills, necessary for life in modern society, to models of education that could meets the needs of not only nowadays but future generations – education in the interest of sustainable development, directed to the achievement of the changes in the human's mind and behavior.

Eco humanist educational paradigm predetermines ascent of the person to higher and higher cultural educational achievements, reference point to which is ecological literacy – ecological scholarship – ecological competence – ecological culture.

Chemical aspects of ecological education include questions of the eco diagnostics, eco toxicology and ecotechnology. Exactly though the integration of chemical and ecological knowledge one can demonstrate negative sides of human influence to the environment, and so possible ways of sustainable development of the society.

The essence, the principles, the aspects, the functions of eco chemical education, the models of ecological education, traditional and innovational forms, the methods of class and out-of-school work, directed to formation of ecochemical competence of the secondary school students are exposed in the present report.

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'INTERPRETIVE FRAMEWORKS' SUPPORTING ARGUMENTATION PROCESSES IN PRE-SERVICE CHEMISTRY TEACHERS: THE ROLE OF META-THEORETICAL IDEAS

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This paper presents results of the analysis of part of the corpus of data generated in an exploratory investigation conducted by one of the authors. In the original piece of research, two 'interpretative frameworks' were proposed in order to analyse fundamental issues selected by science teachers when envolved in argumentation processes. An interpretive framework is here understood as a referential aspect that *guides* an argumentation process, providing a sort of model through which the evidence is read. Two interpretive frameworks were identified so far: *instructional ideas* and *common sense ideas*. In this paper we add a *meta-theoretical* perspective to the analysis, considering the ideas about science employed by teachers when arguing. The methodology of the original piece of research included: 1. participation of a group of pre-service teachers in a video game with science content, *Kokori*[1]; 2. application of post-game survey and semi-structured interview; 3. preliminary analysis of the results obtained (via constant comparative method) in terms of the two original interpretive frameworks. In this paper, we discuss and re-interpret selected fragments from the interviews conducted with chemistry teachers; we focus on a third interpretive framework of meta-theoretical character. The addition of this new perspective allowed us to characterise teachers' argumentation processes through two key ideas coming from philosophical reflection on science; such ideas can be technically characterised as *representation* (the way in which science 'captures' reality with symbolic artifacts), and *correspondence* (the relationship between what science 'predicates' and reality). Results of our re-interpretation lead us to consider that chemistry teachers often rely on these two meta-theoretical ideas when developing argumentative processes, since they talk about the complex, interactive relationships between symbolic entities and the phenomena modelled.

Reference

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TEACHING AND LEARNING SCIENCE AND CHEMISTRY IN ISRAEL

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Science is very extensive and almost every school has a science class. The science teacher should be equipped with both theoretical knowledge of the field he/she teaches and the strategies, methods and techniques of teaching. Science teaching is one of the most important tools in the education system to prepare students for active, accountable and meaningful lives based on science and technology of the 21st century. The last two decades were marked by the "science for all" of science education around the world. During this period, the main goal of science education was shifted from making future scientists to educating the citizens of the future. As a result, science education emphasizes largely the environment and environmental issues within science curricula.

This purpose is implemented from theory to practice in the curricula of science education in Israel. Science education is a growing academic discipline, which explores the existing structures within the scientific content, the student's thinking processes, and the interaction between them. Interest in this area in elementary and post-elementary schools is growing. The technology and hi-tech era that occupied the world turned the control of science and knowledge of these various areas into acquired skills that are essential for professional success of college graduates. The science teacher is highly in demand and science education is a popular and recommended major field of study in higher education institutions. In addition, research in science education encourages the development of a rich and deep perception of the scientific process, aiming to improve the teaching quality of teachers, training in research and development in science and mathematics education, allowing science representation and managing of systems related to science education activities. Research implications in the field of teaching relate to changes in curriculum (content selection, organization and preparation of scientific knowledge) and changes in teaching methods (learning materials and learning environments.

In the Arab College of Education, we developed curricula and conducted numerous studies that related to the following points: Research training in science teaching; Broader interests of science, historical and philosophical perspective; Using educational and cognitive theories in scientific context; Depth knowledge in disciplinary areas; Use of green science in science teaching. Researches in science education at the College are characterized by examining the Israeli education system from the multi-cultural and multi-sectarian perspectives.

USING SOCIAL MEDIA AND ON-LINE TOOLS FOR CHEMISTRY EDUCATION

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Social medial, i.e. Twenty, Facebook, or MySpace, and on-line tools, such as blogging, data visualization and on-line videos, are part of the daily lives of the teenagers who fill our classes. The web 2.0, a term that involves a new way to interact through internet, is a concept based not on the web as a source of information but as a participation platform. This is causing a dramatic change from a communication technology to an active platform to share content.

The creation of on-line communities to improve the quality of learning is, besides recognizing the potential risks of the irresponsible use of the web, a useful tool for education. As recently reported [1], nearly 60 percent of our students use social networking to discuss education-related topics, and more than 50 percent specifically discuss schoolwork to support their education.

It is for that that using social media and on-line tools for Chemistry education will allow students to discover their own passions and share their own interests with kids from all around the world. This presentation will provide some practical examples of the use of these means for Chemistry outreach and understanding especially during the International Year of Chemistry.

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USING APPLETS TO FOSTER ACTIVE LEARNING IN CHEMISTRY EDUCATION

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In this talk we present a number of applets developed by The King's Centre for Visualization in Science (KCVS) that are intended to create rich, active learning contexts in the first year General Chemistry curriculum. In particular we will explore 4 exemplars: The Photoelectric Effect, the Collisional De-Excitation of CO_2 molecules in the atmosphere and applets dealing with both Nuclear Magnetic Resonance and IR-spectroscopy. We will also briefly highlight other applets developed by KCVS that are of specific interest to chemists and provide information on how to access these resources.

YAC AND THE GLOBAL STAMP COMPETITION

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In IYC 2011 CCE realized a **Global Stamp Competition** (GSC)[1], encouraging young people to reflect on national chemical developments and to document their reflections by creating a stamp. Students submitted their designs to a moderated publication platform (MTN, UK) that allowed peer review. They used e.g. Facebook to advertise this peer review. The young 1st prize winner from rural Bulgaria used Facebook (tagged pictures) intensively with her peers to show the world! The day after the ceremony an excerpt of the TV registration was uploaded to YouTube[2]. Results of the competition were shown during the IYC 2011 Closing Ceremony in Brussels[3,4].

The ongoing **Young Ambassadors for Chemistry (YAC)** project from 2004-now[5] aims at young students to promote chemistry through public events. To enable them to do so, the YAC team teaches their teachers (secondary, tertiary) different ways of new content and methodology. New methodology can be achieved in taking part in international projects: using (free) social media like 'Science Across the World' (hosted by ASE)[6] with around 2000 unique page views per month, the SAW Facebook group[7], E-twinning[8], available in most European languages (e.g. for EU Comenius school partnerships) and the (moderated) FactWorld[9] platform to find partners, content and ideas. Groups of students study and explore meaningful content in their local context and share outcomes in work spaces (e.g. E-twinning's Twinspace, global participation permitted), prepare mutual reports, presentations with pictures (Animoto[10]) and videos (YouTube). During the public event they share their local/national results with the public, interact and afterwards they produce picture shows and videos to share on social media with their partners. In privileged countries with more advanced equipment available, smartphones and tablets can add new dimensions[11].

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USING NEW MEDIA TO PRESENT SCIENCE

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Nano science is a relatively new topic in science especially for non scientists. Special exhibits and activities can help broaden understanding about nanoscience [1]. Several activities have been developed that are successful in presenting nanoscience [2]. The education of teachers plays an important role in the effect of activities [3]. Science centres with specific exhibitions (4) and hands on activities [5] can also be important in demonstrating specific aspects of science. Science LinX (www.sciencelinx.nl) is the outreach organization within the faculty of mathematics and natural sciences of the University of Groningen. Apart from the physical exhibits in the entrance halls of several buildings of the faculty the group also maintains a website, www.sciencelinx.nl, through which students can find information and are able to pose questions through email. Part of Science LinX is a network of local science teachers that works together with local university staff on the development of educational material.

Science LinX is involved in the organization of science festivals such as the night of arts and sciences (http://www.denachtvankunstenwetenschap.nl/en). On June 2, 2012 the next night will be organized.

For the development of exhibits during the festival students of the master in science education and science communication of the faculty of mathematics and natural sciences are involved. Two of these exhibits will be presented here. The first is molecular city, the other an augmented reality program focused on size of objects of research, reaching from light years in astro physics, through to sub atomic particles in physics.

Molecular City is an application that can be used on the IPhone or android phones. Using specific markers it shows a specific molecule underneath the surface, thus demonstrating the molecular nature of matter.

The other program is web based, markers on a handheld cube are used to bring forward short one-minute presentations by researchers about their research within a size margin, eg the molecular motor in the nanometer range [6].

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WIKI-BASED LAB REPORTS: AUTHENTIC ASSESSMENT FOR LEARNING

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The introduction of high impact teaching practices in a chemistry laboratory environment, including undergraduate research projects and inquiry/discovery experiments, requires new approaches to the assessment of the related student learning outcomes. Collaborative learning environments promoted the construction of new knowledge through shared ideas and, in the laboratory, extend to the development of research questions, experimental design and the communication of subsequent outcomes. Conventional lab notebooks and hard copy reports do not evidence individual student contribution to collaborative processes/decisions during their experimental design and the subsequent analysis, processing and communication of their data in relation to their research question(s). The introduction of a virtual lab notebook hosted within a Wiki environment enabled the mapping of individual contributions to a collaborative group report. Issues such as the incidence of plagiarism could be addressed both through the inherent transparency in accountability and the ability to submit an electronic copy of the product to Turnitin.

The effectiveness of the lab notebook Wiki was explored through analysis of the Wiki content and histories for three separate groups of students. All students in each of these groups consented to participation and accessing their wikis after the course had been completed. Evaluation included: counts of the number of characters, views, comments and chronological events to map the contribution of each student[1] and the characterization of nature of the textual entries and comments[2]. The response of the group to online tutor feedback within the wiki was also assessed. All students in the course were invited to complete an online interview which explored their perceptions of the role and the impact of the wiki on their experiences and processes in the lab. Strong evidence emerged from this data that the wiki environment had promoted shared understanding of experimental processes and subsequent interpretation of data. A positive outcome emerged in terms of their shared understanding of the collective process and their engagement in the course.

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"PROMOTING CHEMICAL EDUCATION COLLABORATIONS AMONG FOUR-YEAR INSTITUTIONS AND HIGH SCHOOLS"

Experimentation in chemistry at the high school level is often restricted by the school districts because of the inherent risks of storing chemicals in classroom/teacher's prep areas and the lack of modern instrumentation. Florida Southern College (FSC) recognized the deficiencies in high school chemistry preparation and implemented collaborations with three local high schools. Students enrolled in the Advanced Placement (AP) Chemistry course come to FSC to perform experiments in a college setting. FSC students also participate in the outreach effort by serving as teaching assistants in the labs. College students take turn in developing a lab and leading the pre-laboratory session. The experience promotes deeper learning in chemistry for the college students and affords them an opportunity to enhance their communication skills. In addition to the chemistry labs, FSC faculty and students have organized career opportunities and outreach events in the community to celebrate National Chemistry Week and Earth Day.

This presentation will also address the importance of professional development opportunities for high school and college faculty and provide examples on how to engage local industries, professional organizations and higher education organization in these efforts.

ON THE RELEVANCE OF CHEMISTRY FOR YOUNG PEOPLE

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The international study, named ROSE, i.e. The Relevance of Science Education, as well as many other studies, show that lack of relevance for young people in developed countries makes them loose interest in Science, and Chemistry. This has tremendous bearings for the modern society, which strongly depend on the achievements within Science and technology, as well as on a well-informed participation for all of its citizens. The latter is absolutely crucial for the development towards and the maintenance of a sustainable society.

In this presentation we will give some examples on issues and ways in which the importance and attraction of chemistry to every child and young person can be enhanced, in our experience as teacher trainers as well as school chemistry teachers. We seek our answers partly amongst the young, in didactical literature about chemistry teaching and partly by “trial and error”. We cannot show you a golden rule by which all the problems can be solved, concerning how to improve chemistry learning amongst our young, but we wish to make a contribution to the discussion of Best practice and hope for your devoted response. We are convinced that this work needs the input of many a teacher and probably with various means.

Questions that we address:

What inspires young people?
How can we improve the level of understanding?
The chemistry teaching of tomorrow – where are we heading?

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CREATIVE METHODS FOR TEACHING AND LEARNING CHEMISTRY

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Chemistry plays a central role in the world in which we live. For example, global warming, climate change, water resources, and energy sources require a strong background in chemistry and cross-border collaborations in order to solve the serious problems our planet faces. We must guarantee that we have enough chemistry students in the pipeline so they can become the problem-solvers of the future. Sadly enough, chemistry is often perceived with a negative image. However, an effort has been made during the past three decades to develop creative methods of teaching, learning, and assessing chemistry for all educational levels -- elementary schools, high schools, universities and for the general public[1]. These methods can be used both in formal and informal settings. A Chinese proverb states: "I hear and I forget; I see and I remember; I do and I understand." Creative methods of teaching chemistry take into account this Chinese proverb. The part "I see and I remember" is translated into visualization techniques in chemistry, but the most important part, "I do and I understand," is translated into hands-on experiments. In this method, students produce their own visualization projects in order to communicate their understanding of abstract chemical concepts. These visualization projects can take the form of art, music, dance, drama, computer animations, cartoons and poetry[2]. Examples of a variety of projects will be presented in this symposium.

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POPULARIZING CHEMISTRY THROUGH HISTORICAL PLAY OF FINNISH NOBEL LAUREATE

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The use of drama in science education has been recognized as a teaching method. However, it is quite new as a research field. When drama is discussed, it is often viewed as students simulating social situations (e.g. Dorion, 2009), which may make it easier for them to empathize with different opinions and to promote mediating socio-scientific issues. Some research on teaching science concepts in science theatre emphasizes the student audience's interaction with the professional actors (eg. Wieringa, 2011; Peleg, 2011). In this case study, a more classic play depicting historical scientific work and the play's educational possibilities were studied.

This case study focuses on a play about Finnish Nobel Laureate in chemistry. The study is based on a survey targeted to the audience of the play. The survey was conducted using a questionnaire including both open-ended and multiple-choice items. The aim of the study was to gain insight on the learning outcomes of watching a play depicting historical events from a scientist's life. Also, the audience's opinions about the importance of history of chemistry were mapped.

The play was performed four times in 2011 and 2012. The audience consisted mainly of scientists and science teachers. The first version of the questionnaire (N=58) was used to develop the second version that was handed out for the audience to answer in February 2012 immediately after watching the play (N=126).

When asked, what can be learned from the play, the specialists (scientists and science teachers) in particular brought out possibilities to learn about Nature of Science (NoS) issues. Perceived NoS learning opportunities included, eg. (i) seeing the humane side of scientists, (ii) social dimensions of science, and (iii) the interaction of science with society and technology.

The results indicate that several NoS issues can be presented in a theatre performance and recognised by the audience. It indicates that play can be a meaningful history and philosophy of science (HPS) informed setting for learning Nature of Science contents.

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INTEGRATED LECTURE-LABORATORY COURSES TO PRODUCE EDUCATED CITIZENS AND CONSUMERS

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As a long-time teacher of the non-major chemistry course, this author has been developing and modifying two non-major chemistry courses, Chemistry and Society and Consumer Chemistry for over 15 years with the goal of producing scientifically literate individuals. Although textbooks were used previously, there were, in the author's opinion, no suitable textbooks to cover the range of topics desired. The Internet was still in its infancy without the diversification available today, but there were still many resources available. Currently, the courses are taught as hands-on lecture-laboratory courses without a textbook. Chemical principles are taught on a need-to-know basis relying on information supplied by the author, articles from magazines and journals, and links to applicable internet sites along with applicable laboratory experiments posted on the author's course web pages.

Topic: Didactics of Second Level Chemistry. Best practices in the teaching and learning of chemistry: international sharing of methods, insights, and results.

REVISITING THE DANIELL CELL

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In this talk we will argue that the common Zn/Cu cell as depicted in textbooks should be reconsidered as a model for a galvanic cell in the teaching of electrochemistry at an introductory level. This is based on historical, chemical and pedagogical arguments. Recognizing the prominent role this model has played, and still plays, in (mis)understanding electrochemical concepts, together with its widespread use over a long period, we suggest some figures to facilitate a transition. Our intention is to provide a springboard for further improvements.

CAN WE IMPROVE OUR MODELS AND PRACTICE IN ELECTROCHEMISTRY EDUCATION?

Per-Odd Eggen, Astrid Johansen

Electrochemistry is a normal part of general chemistry curricula and textbooks. Since the beginning of the 19^{th} century, there has been a tremendous technological and scientific development in this field, but the school subject does not always mirror the current situation. Instead, many chemistry textbooks deal with out-dated examples and models that can lead to a suboptimal electrochemistry education. At the same time, examples from modern technology such as lithium-based galvanic cells provide opportunities for new and possibly better models. Leaving some of the old models behind may actually ease the understanding of electrochemistry and also open to new alternatives in the school laboratories. In this session, new examples of basic laboratory experiments and models will be presented and discussed.

CLAIMS AND EVIDENCE – LINKING ARGUMENT-BASED INQUIRY WITH THE SCIENTIFIC METHOD

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One of the most important aspects of teaching any science is to convey the methodology of scientific investigation in such a way that students develop the skills that are fundamental to scientific inquiry and the scientific way of processing information. As students develop their own testable questions about the system being studied, design experiments, formulate claims that can be substantiated by the evidence, develop multimodal models to represent this understanding, and subsequently share these with others by engaging in open discussion, debate, and scientific argumentation, students become immersed in scientific endeavor. In the process, students learn to reflect on this discourse, they come to challenge their preexisting beliefs while they refine their original claims as new evidence becomes available. In this session, we will share examples of these strategies and suggestions on using these strategies in the classroom.

DECISION-MAKING ON SOCIOSCIENTIFIC ISSUES – ANALYSES OF INFLUENTIAL ASPECTS

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Decision-making is one important goal of science education because the ability to make decisions on socioscientific issues should be fostered by the integration of scientific knowledge (Sadler & Zeidler, 2005). Additionally to content knowledge, the process of decision-making requires several other elements: identifying criteria, using evaluation strategies and drawing a conclusion (Kortland, 1996).

The present study investigated decision-making in science within the framework of National Educational Standards. The German National Educational Standards for chemistry define the ability of decision-making as *evaluation and judgement competence* (KMK, 2005). First aim of the presented study was to compare the subjects chemistry and biology in order to investigate if a chemistry specific evaluation and judgement competence can be separated from other subjects or everyday life situations. The second aim of the study was to analyse influential aspects on the decision-making process (e.g. content knowledge, cognitive abilities, knowledge of strategies). The data collection was based on a quantitative design. Items concerning the evaluation and judgement competence as well as influential aspects were developed and used for the assessment of 780 students of upper secondary school in Germany.

By using Rasch-analyses, regressions and structural equation models the data were investigated. The Rasch-analyses show that the competence of decision-making on socioscientific issues is a domain-specific competence. The deviance and the information criteria (AIC, BIC, CAIC) are lower by using a more-dimensional model. The regressions and the structural equation models show that the decision-making competence in chemistry is especially influenced by content knowledge and evaluation strategies as well as cognitive abilities. Influential aspects like environmental attitudes and social desirability have a negligible influence on the decision-making competence.

These results can be used to foster the ability to take decisions in chemistry specific contexts.

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DEVELOPING HIGH ORDER THINKING SKILLS IN GIFTED STUDENTS THROUGH PROBLEM MANIPULATION AND CLICKERS

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A classroom teaching approach, with the use of clickers, to develop High Ability Learners' acquisition of problem-solving and critical-thinking skills is described.

In this approach, selected gifted senior high school students from Raffles Institution, a premium Singapore school, were introduced to novel situations in two module lessons developed - Structure and Reactivity of Hydrazoic acid, HN_3; Ellingham Diagram in Thermodynamics. They are required to use principles and concepts that are within their learning syllabus and apply them in a logical, reasoned or deductive manner to solve unfamiliar higher order thinking problems. Multiple choice questions were developed to scaffold, engage and guide students to explore, review, evaluate and provide solutions for the complex situations.

The histogram function of the clicker program enables teachers to gauge students' understanding right away. The clicker program provides teachers and students with prompt, regular and relevant **feedback** that is important to this teaching and learning process in helping students become more proficient problem solvers."

STUDY ON THE CHEMISTRY EPISTEMIC STYLE OF HIGH SCHOOL STUDENTS

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Chemistry epistemic style refers to the way by which individuals reflect actively toward objective things from the chemical perspective. This is the thinking pattern that students tend to adopt when thinking about or handling chemical problems. Likewise, this is the measure or pattern of information processing adopted by students when comprehending or solving chemical problems. Chemistry epistemic style is characterized by the features of stability, content attribute-based, educability, and elusiveness. Chemistry epistemic style includes two components, namely, epistemic perspective and epistemic style category. The organic integration and unified action of epistemic perspective and epistemic style category results in the epistemic style that favors certain epistemic field. Another outcome is the formation and development of epistemic style which is related to the function and value of epistemic development of core knowledge.

This study has surveyed the degree of identification of chemistry teachers and researchers on the configuration model of chemistry epistemic style through questionnaires. According to the survey results from 4889 chemistry teachers and 22 chemistry researchers, both chemistry teachers and researchers agree on a particular level with regard to the epistemic style proposed by this study. Through analysis on construct validity of measurement tools developed based on the configuration model of epistemic style, the researcher checked the rationality of the configuration model of chemistry epistemic style. The result of statistic analysis on survey data of chemistry epistemic style of 764 high school students from different regions and schools with different levels and stages of learning indicates that the chemistry epistemic style built by this study conforms to the configuration of chemistry epistemic style of high school students. Based on the configuration model of epistemic style, this study has analyzed the epistemic styles from the four perspectives of epistemic topic, epistemic style, epistemic ability, and function and values of epistemic development on chemical knowledge in the four epistemic fields of organic chemicals, inorganic substances, chemical reaction, and electrolyte solution. Subsequently, the configuration model of chemistry epistemic styles and hierarchical model of epistemic development for the above four epistemic fields are built. This study has analyzed the chemistry epistemic styles reflected by teaching books at different stages on the above four epistemic fields through the textual analysis method. Moreover, the study has provided theoretical basis for the model of epistemic style and hierarchical model of epistemic development for the four epistemic fields mentioned above. This empirical study indicates that both the pedagogy and books used in teaching affect the formation and development of chemistry epistemic style of high school students. However, when the teaching book does not describe clearly the chemistry epistemic style, teaching will be an important factor that can influence the epistemic style development of high school students. The thinking style (cognition style) of students is not relevant to the chemistry epistemic style.

Key words: chemistry epistemic style, epistemic development

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PROBLEM SOLVING IN SCHOOL CHEMISTRY EXPERIMENTS IN DEBATE

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Experiment is regarded as an essential tool of evidencing in science and experiment-based inquiry has been used in school chemistry education as a method raising problem solving ability. However, in many science/chemistry textbooks, especially in Korea experiments and inquiries based on experiments have been introduced to confirm the theoretical concepts rather than to foster problem solving ability. The passive role of chemistry experiments in such way can be transferred to its active role as evidencing methods and problem solving by using some intrinsic nature of chemistry experiments requiring proper experimental conditions for correct control experiments.

This study introduces two cases of experiments that are widely introduced in science/chemistry textbooks of the grade 7 to 12. Their results are simply anticipated based on theory but the experimental observations do not properly correlate with the theoretical expectation. One example is that the colour of sodium flame is written as yellow but many students observed non-yellow colour.[1] Another is that the observation of molecular diffusion rates of HCl(g) and NH_3(g) within a tube and a drop of HCl(aq) at one end of the tube and a drop of NH_3(aq) at the other end. The theoretical expectation is simple based on Graham's law,[2] and however, the observation does not easily correlate with the theory under school level. These experiments are in debate in school and only arguments exist without evidencing. In this study, school level experiments have been performed to clarify the issues in debate and the process of evidencing is considered as a good example of problem solving material with school level chemistry experiments.[3]

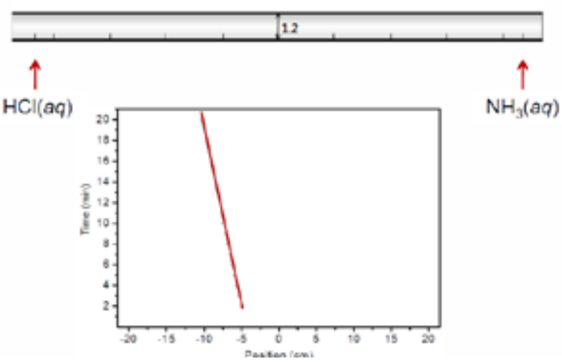

Figure 1. Position of NH_4Cl(s) along the tube.

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STUDENT' CONCEPTION IN PRIMARY TEACHER EDUCATION ABOUT MATTER AND ITS TRANSFORMATION

Since the advent of Piaget theory, much research has been done about primary teachers' conceptions of matter and its transformation. Most of these conceptions have been identified as erroneous compared to scientific conceptions (Métioui and Trudel, 2010). The present research has for object to uncover the conceptions of Preservice teachers with respect to the states of matter and their transformations. Eighty students participated in this research in the context of a course on science teaching in a training program for primary school. We have experimented with them a constructivist teaching approach to help them learn the physical transformations of matter. The experimentation took place in four sessions of three hours each per week and included the following steps: (1) answering a multiple choices questionnaire of duration of sixty minutes to identify the conceptions of students about the transformations of matter before teaching; (2) confrontation of the conception of the students; (3) viewing an educational movie. After viewing the movie, the students had to revise their answers to the questionnaire given in the introduction; (4) presentation by the teacher about the physical transformations of matter. To identify the conceptions of the students after teaching, we have them answer a multiple choices questionnaire of duration of sixty minutes that included eight questions. Each question was formulated as statement they had to answer true or false and justify their choices. This way of proceeding was put in place in order to know not only if they have learned the intended concepts but also to discover if the harbored any erroneous conceptions. Besides, the questions were formulated so that the student cannot answer mechanically and must draw upon his conceptual structure. For example, one of the statements of the questionnaire asked them to indicate if the following statement is true or false, while justifying their choice: When one transforms water, from the liquid to the solid state, the distances between the atom of oxygen and the two atoms of hydrogen that compose every molecule of water decrease. For 14% of the students, this statement is true (false conception). However, for 30%, the distances between the atoms those compose water increase (false conception). For 23% of the students, this statement is false because it is the distance between the molecules that decreases (false conception). The results of our research demonstrate that it is possible to foster the evolution of the spontaneous conceptions of the students toward scientific conceptions.

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ALTERNATIVE DOCUMENTATIONS OF EXPERIMENTS – A DIFFERENTIATION AND DIAGNOSIS TOOL IN CHEMISTRY LESSONS?

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For many years, especially since PISA, teachers have been expected to reflect possibilities of individual learning in (chemistry-) school lessons [1]. Several approaches dealing with students' individual cognitive and conceptional ideas have been developed [2,3,4]. As a prerequisite to develop and implement appropriate differentiation principles teachers should have the ability of diagnosing students' learning conditions, abilities and difficulties [5]. Consequently holistic diagnosis is an essential element of teacher competence. Apart from the school context (formal learning) also extracurricular activities (informal learning- settings, like competitions and out-of-school lab-days) offer opportunities for the teachers to develop diagnostic competences and to sample and evaluate differentiation and supporting measures for the students [6]. The presentation will outline a project which in a short term aims at testing whether alternative forms of documenting experiments can serve as an appropriate differentiation method. In the long term it aims at examining whether these differentiation measurements can also serve as diagnostic instruments and therefore enhance diagnostic competence in teacher education.

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DIDACTIC ANALYSIS OF COMPUTER SIMULATIONS AS A MEAN OF INNOVATION IN THE PRE-GRADUATE CHEMISTRY TEACHER TRAINING

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The fast development of the information and communication technologies supported by increasing number of interactive boards in Czech schools provide conditions for applying the Comenius´ principle of clear explanations in chemistry teaching saying that not only demonstrative and pupils´ experiments can be used but their computer simulations as well. These are not clearly scientific ones; they are adjusted to the learners´ cognitive level. It means that redundant professional information is reduced, while the didactic support forming the learner's process of cognition is added. Simulations are a special type of modelling, when time characteristics of phenomena are presented. Generally, simulations and animations are methods replacing the researched dynamic system by a model presenting the modelled system in operation or can be used for running experiments. The teaching and learning supported by computer simulations and animations reduce real phenomena so that the predefined learning objectives could be reached, support the process of forming images about the reality in learner's mind and continuously reflect the researched reality[1].

The research study describes results of the didactic analysis of acid-base titration simulations from the point of their availability and instructional quality. The acid-base titrations as example of the computer simulation were selected mainly from two reasons. The first one is their frequent open access on the Web when they work as training how to handle with the real apparatus or bring the theoretical knowledge to real laboratory practice. The second reason is the demandingness of the selected topic. The acid-base titrations at secondary grammar schools are usually taught within the topic of Theory of acids and bases and are presented in the form of pupils´ experiment. The topic is complex when combining theoretical knowledge on acids and bases, calculations of chemical equations and practical experimental activities. As the students´ experiment usually cannot be repeated, simulations and animations can significantly contribute to understanding and fixing the related knowledge and skills.

The didactic analysis (sample of 35 acid-base simulators) described in the full text, its results and application in pre-gradual chemistry teacher training comprise one of approaches towards developing the chemistry teacher competencies in the information society.

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A HAPTIC-ENHANCED FRAMEWORK FOR CHEMISTRY EDUCATION

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Haptics, the technology that exploits the human sense of touch by allowing user to apply or feel forces and vibrations, can be greatly helpful in the chemistry education context: the forces involved in the chemical interactions can be directly simulated and felt by a training system through the usage of a haptic device. At this aim, we have developed a virtual environment for the exploration of the space around a molecule, where the electrostatic surface and its influence on the surrounding objects can be explored with the help of a haptic device, to better understand forces involved in intermolecular recognition phenomena [1]. A deep understanding of these forces that govern the binding processes is fundamental in chemistry teaching: interactions among molecules are typically described only as huge sequences of data, which determine how the attraction/repulsion forces take place and find the positions of binding sites on the molecular surfaces. This huge amount of data is awkward to be interpreted even by experts of the field; haptic interaction allows the user to *feel* the interaction forces, improving the comprehension of different didactic topics. User interaction is also enriched with visual cues and auxiliary data related to the user-experienced phenomena to ease the comprehension of the theoretical concepts underlying the described phenomena [2].

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DIDACTICALLY CORRECT SENSORS FOR DIGITAL LABS

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Recent decade digital labs became wide-spread in chemical education. They introduce and visualize concepts that used to be abstract (such as pH) and introduce quantitative laws and patterns. However the sensors are developed rather by engineers than by teachers. Some of them are habitual technically but are not the best solution for didactics. Developing our digital labs Nau-Ra we based on learning tasks and developed sensors for them. As a result our system differs from the majority of other systems in several issues.

For quantitative characterisation of reactions with gas release we use a sensor of gas volume instead of gas pressure that is used in many labs. It is more visual, because students observe volume change. It is easier to process the results, because to calculate amount of a substance one needs to know only temperature (at 20°C amount (mol) = 24 χ volume (litre)), whereas using pressure – also gas volume in a vessel that. It is more safe because does not require excessive pressure in reaction vessels.

Another sensor that was developed basing on tasks is optical density sensors. Conventional sensors employ 3 ml cuvette that is put into a covered container. Students do not observe what is happening in the cuvette and they don't form links between observable effect (colour) and its digital characteristics. They also can not add anything to a cuvette to see how the optical density changes. Our sensor is a gate that is put on an open 100 ml cuvette. The students can see what is happening in the cuvette and add to it whatever he wants. Sensor with immersion probe holder would be even better but expensive solution.

We also developed automatic burette based on syringe with plug shift measurement. It is more precise than conventional drop counters and allows varying rate of titrant adding from one drop per minutes to millilitres per second.

There are also problems that are not solved yet: water sensor for organic liquids (to research equilibrium of esterification), high-temperature sensors of combustible gases and its products (to research process of combustion), cheap polarimeters (to investigate optically active substances and reactions with them), *in situ* refractometers (to investigate organic reactions) cheap thermogravimetric system etc. So, developing sensors starting from learning task is still up-to-date problem.

LEARNING OUTCOMES AND THEIR ASSESSMENT IN THE OPINION OF JAGIELLONIAN UNIVERSITY LECTURERS

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The Learning Outcomes (LO) are a notion that was introduced to the Polish secondary education at the end of the 20^{th} century together with external exams (the first national exam took place in the year 2002). In connection with the implementation of the new Act on Higher Education in 2011, the notion of LO found its way to universities. The Ministry has developed the so called area-specific learning outcomes (in the area of exact, technical, natural sciences etc.). Based on these guidelines, individual faculties develop LO for all study subjects (major), and individual lecturers shall develop LO for their modules and courses. In order to prepare effective training for lecturers, a questionnaire examining their current knowledge about LO and, inseparably connected with it, the LO's assessment has been conducted. Its aim was to discover: How do lecturers define the notion of the learning outcome? Is there a correlation between this definition and the participation in any kind of training related to this topic? How do lecturers define the course objective and how do they define its outcome?

Most respondents define LO in congruence with the interpretation that it is as a result, outcome, effect, change. While the course objective is defined mainly as a process – teaching, systematisation of knowledge, introduction, information – the outcome of the course is defined by majority of respondents through skills. It leads to a conclusion that during staff development activities it may be possible to rely on the intuitive, and based on superfluous contact, understanding of the phrase "learning outcome".

In the case of assessment of the learning outcomes it has been found that e.g. less than half of the respondents agree that it is necessary to assess key skills (generic skills), and as many as 80% of academic teachers and 90% of doctoral students agree with the statement that roles in a group should <u>not</u> be imposed because the group works better if it chooses the leader itself - both attitudes can pose a possible problem for quality assurance.

The positions of JU lecturers and doctoral students were compared with the LO assessment standards common in the UK [1].

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SUPPORTING LEARNING IN CHEMISTRY WITH FEEDBACK FROM A CONCEPT INVENTORY

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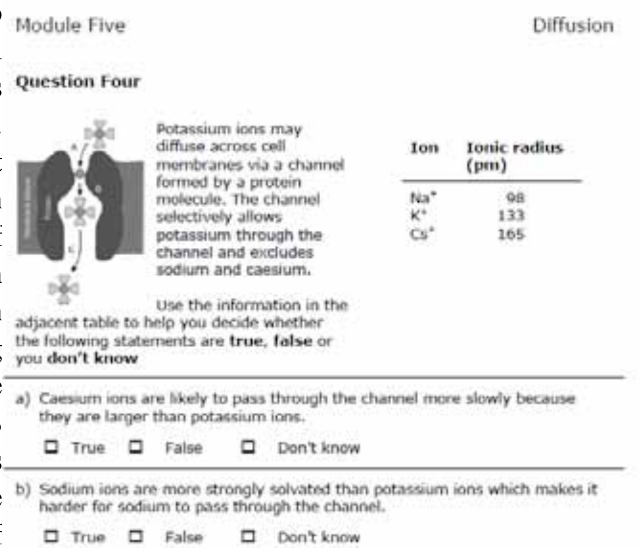
One of the most important ways of increasing student learning is feedback, particularly when it involves feedback from students to teachers resulting in more appropriate teaching[1] This paper will take the form of an interactive workshop in which we will explore the nature of feedback that meets the Hattie criteria by supporting student learning, through personal feedback and through feedback to the teaching academic, made possible through online formative assessment. The session will involve a brief introduction to the Molecular Life Sciences Concept Inventory[2], the online formative assessment tool that has been used to generate the data for the discussion.

As teachers we want our students to build a coherent and sophisticated personal model of the molecular world that is useful in their everyday lives and careers. Feedback is critical in this process, and it should be both timely and not a burden on the teacher. The semi-automation of the feedback process that is possible with online delivery can reduce the burden and has the added advantage of providing access to international referencing. The session will use examples from the MLS inventory to explore the possibilities for feedback. The issues will range from practical topics such as the use of particular types of questions to maximize information, to statistical methods for aggregating results to provide feedback about the coherence of conceptual understanding.


Module Five Diffusion

Question Four

Potassium ions may diffuse across cell membranes via a channel formed by a protein molecule. The channel selectively allows potassium through the channel and excludes sodium and caesium.

Use the information in the adjacent table to help you decide whether the following statements are **true**, **false** or you **don't know**

Ion	Ionic radius (pm)
Na^+	98
K^+	133
Cs^+	165

a) Caesium ions are likely to pass through the channel more slowly because they are larger than potassium ions.

☐ True ☐ False ☐ Don't know

b) Sodium ions are more strongly solvated than potassium ions which makes it harder for sodium to pass through the channel.

☐ True ☐ False ☐ Don't know

The final part of the session will explore methods for teachers to take advantage of the feedback to enhance their teaching, including the translation of conceptual questions for classroom use, such as the use of clickers and the role of collaborative group learning. While the immediate application of feedback is paramount, the data from formative assessment items also has a longer term role in course development. The issue of marrying formative assessment data with other data from the course such as summative examination data will be canvassed.

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CHEMED DL WIKIHYPERGLOSSARY: CONNECTING DIGITAL DOCUMENTS TO ONLINE RESOURCES WHILE COUPLING SOCIAL TO CANONICAL DEFINITIONS WITHIN A GLOSSARY

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This presentation will describe features of the multilingual WikiHyperGlossary being developed for ChemEd DL, the Chemical Education Digital Library. The WHG automates the markup of digital documents and web pages by linking words in those documents to the content of a glossary database. When a link is activated the definition is superimposed on the document in the form of a JavaScript overlay. We will discuss a strategy for improving reading comprehension of digital text-based resources in one's distal knowledge space by coupling novice-level wiki-generated social definitions to expert-level peer reviewed, non-editable, canonical definitions. This could expand the usability and functionality of IUPAC glossaries.

For chemicals there is an associated InChI (International Chemical Identifiers) in the database that is used to communicate to a variety of software and search agents. Through these features the WikiHyperGlossary can both provide chemical information about a molecule by connecting it to search services (RSC ChemSpider), and populate 2D editors (JChemPaint) and 3-D visualization applications (Jmol) with that molecule. Without ever leaving an article someone can acquire information and visualizations on a molecule mentioned in the article, as well as change the molecule and acquire information on this new molecule.

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7 WAYS TO MODEL A SODIUM CHLORIDE SOLUTION IN THE CHEMCOLLECTIVE VIRTUAL LAB

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The ChemCollective is a project of the Department of Chemistry of Carnegie Mellon University that aims to develop resources to enhance chemistry teaching and learning. One of its main developments is the Virtual Lab which was first presented in 2000 and has been since then available at no cost in the ChemCollective website[1]. This tool is a macroscopic simulation of a chemistry laboratory for aqueous solutions. Currently, it includes in its downloadable international version more than 110 problems (in total) in 8 different languages[2].

Furthermore the available problem list can be easily expanded using either with the Autoring Tool also available in the website or directly editing the XML files that encode the problem repository.

When developing new problems different types of models can be used. However, as it commonly happens when dealing with educational simulations, these models go undocumented and most users are unaware of their limitations.

This communication aims to document some of the models that can be used when writing virtual lab problems and explain both how to use them and the limits of the simulations obtained in either case.

Seven ways to model a sodium chloride solution are presented and the properties (concentration, density, volume, specific heat, melting point, boiling point) obtained with the simulation will be discussed against the expected values. These comparisons will serve to expose the importance of taking into consideration the "hidden" models when using any virtual laboratory.

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MATERIALS FOR PUBLIC UNDERSTANDING OF CHEMISTRY

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Chemistry is central science for the progress and security of human living. Nevertheless, understanding and appreciation on the role of chemistry and the image of chemistry is weak. Therefore, chemists and chemistry educators are eager to promote the importance of chemistry for students and public to sustain the progress of their life in the future. One important way is to provide students and public with information and materials interested and needed to them. Nowadays, students and public learn and get their information for their interest and study from internet and other media resources. Therefore, chemists and chemistry educators help to generate information and materials on chemistry as resources for the webs and other media. "Technology Milestones from the Chemist's View" was originally published by the American Chemical Society in 2001 in poster forms to increase the public image of chemistry. There are four areas in the contents of posters: Energy and Transportation, Information and Communication, Health and Medicines and Food and agriculture. We translated these contents in Korean and published them as a book1 and on the web2, respectively. Furthermore, we expanded the web version by adding more information to the key words and key concepts. It is necessary to provide more information in easily accessible and easily understandable forms in the public' view.

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REBOOTING INTO HTML5 AND MULTIPLE DEVICES

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The *Journal of Chemical Education* has published non-print, digital content since 1988 as *JCE: Software*[1]. Digital publication requires updating content to remain viable with existing media and standards. We present here our latest update involving the transformation of content to HTML5 and support of multiple devices (desktop computers, tablet, pads, and smart phones) for presentation of the content. Our vision is a digital publishing platform for shared learning objects that can be consumed on multiple devices and integrated into the social media fabric of today's web.

The first step toward this vision is the reboot of JCE Online (the former site of the *Journal of Chemical Education*) into a modern web platform. To architect such a platform we have used Drupal and embraced the concept of "content as a service". Through the implementation of web services, we are providing our content to other applications that exist on other platforms. For example, our video collection is available on mobile devices through an application that requests information from our web site and presents it on the mobile device. Conversely, we consume information from other social media web sites to help characterize the use of our content and increase its discoverability.

Making the transition from static to dynamic, interactive web content is not done without overcoming obstacles. One of the promises of HTML5 is consistent presentation of media objects such as audio, video, and animation. However, the implementation of HTML5 has not met the promise from the standpoint of the content provider. We will present our approach to some of the problems we encountered in the hope that others considering similar transitions might benefit.

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THE OWLBOOK, A FULLY INTEGRATED, INTERACTIVE ONLINE TEXT FOR GENERAL CHEMISTRY

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This presentation will review the creation and testing of an assignable, fully integrated online textbook and homework system for general chemistry. This project is an extension of the OWL electronic learning system, which combines highly parameterized homework questions with rich, detailed feedback along with conceptual learning exercises and tutorial help. The new integrated text combines text, conceptual learning and problem solving into interactive reading assignments where students work through both the readings and the graded explorations and problems. While the organization of the material is traditional in order and scope, the presentation intermixes noninteractive material such as static explanations, video examples, and whiteboard problem solutions with interactive and assignable figure-based exercises, concept simulations, tutorials and problem-based homework.

Each section of interactive reading assignments is followed by a set of mastery homework questions. These questions are categorized into units covering each content area. The chapter ends with a set of general and challenge questions, as well as questions relating the chapter content to students' lives using the students' own personal data inputs.

The principal goal of the project is to create a system in which the students experience "text" and assignable homework as an integrated whole. Results from tests with a dozen classes will be presented, highlighting how students navigate the system, which parts they do and do not use, and how assignability influences their decisions as to how to use the system.

TEACHING INNOVATIONS: USING TECHNOLOGY TO ENRICH THE TRADITIONAL

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An explanation of the practical innovations experimented with in the School of Chemistry and description of how these informed the innovations developed for the Bristol ChemLabS Centre for Excellence. Many changes make full use of e-learning which enriches the understanding students have of the practical experience. Crucially, e-learning is not replacing the real hands-on practical experience but allowing students to take on *more* challenging experiments. More sophisticated and educational online tools are used in the second year.

- An integrated approach (across organic, inorganic and physical chemistry) to practical skills.
- The blended use of standard and intensive laboratory periods.
- The use of a variety of assessment methods.
- The use of a Dynamic Laboratory Manual
  - Online prelab work remotely available
  - Online safety assessment with real-life events to consider
  - Animated, interactive diagrams of apparatus – allowing students to 'get it wrong' in a safe environment.

THE CHEMCOLLECTIVE: VIRTUAL LABS AND TUTORIALS FOR INTRODUCTORY CHEMISTRY

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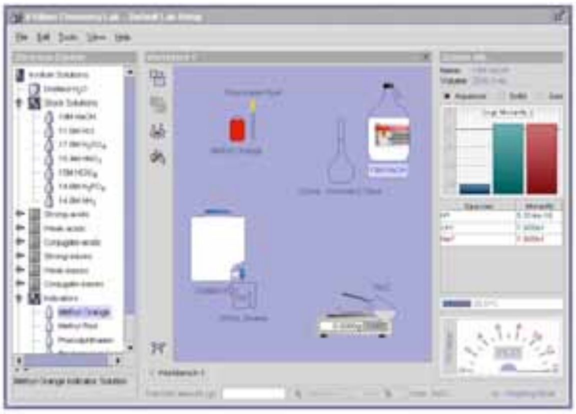

The ChemCollective virtual lab (www.chemcollective.org) is an open-ended learning environment in which students design and carry out their own experiments, while experiencing representations of chemistry that go beyond what is possible in a physical laboratory. The goal is not to replace or emulate the physical laboratory, but rather to supplement textbook problem solving by connecting abstract concepts to experiments and real-world applications. The lab provides a flexible means for authoring of learning activities, and more than half of the one hundred existing activities were contributed by the user community. The software is available in over thirteen languages and about 175,000 students perform an experiment in the virtual lab each year. Results from a number of learning studies will be summarized, to highlight how engaging students in the design and interpretation of experiments can enhance learning.

The ChemCollective also has a collection of tutorials, including a set that illustrates a new approach to chemical equilibrium instruction that has been shown to more than double student performance on difficult chemical equilibrium problems[1,2]. This new approach is based on a number of studies that exposed “tacit knowledge” in chemical equilibrium. Such tacit knowledge is obvious to experts and so instruction fails to make it explicit to students. One such class of tacit knowledge relates to chemical reactions being rules that, when applied to a collection of molecules, generates a progress-of-reaction coordinate. The other such class of tacit knowledge is that analysis of chemical equilibrium systems occurs in two phases, the first of which determines the concentration of majority species in the solution and the second of which determines the concentrations of the minority species.

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WEB BASED ACTIVITIES FOR BEFORE, DURING, AND AFTER CLASS

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This presentation will outline instructional activities that link large class lecture settings and web based instructional materials through before (BCEs), during (DCIs), and after class (ACAs) activities. The Before Class Exploration (BCE) is a web-based exercise students complete before they attend a lecture. A BCE can consists of a data collection activity using a simulation program along with a few questions about the data, or a set of 5 to 7 questions introducing a concept to be covered in lecture. The activity runs through a web browser and should require only 10 to 15 minutes of a student's time to complete. Upon submission of the BCE, students receive a copy of their responses and, when appropriate, an expert's response to the questions for comparison. The instructor can access all student responses to the BCE prior to lecture to gain a better picture of the student's pre-existing knowledge, which will allow lecture activities to be customized. The During Class Invention (DCI) uses data generated in the BCE, along with questions/problems to develop a concept that focuses on a course learning objective. During class the DCI is completed by small cooperative groups. Students report their consensus response for the instructor's consideration using a student response system ("clickers"). The After Class Application (ACA) is a web-based set of questions that allow students to apply their knowledge of the concept introduced by the BCE and 'invented' by the DCI. The questions on the ACA will be both conceptual and algorithmic. Since both the BCE and ACA are web-based, all responses are stored in a relational database. Although a stand-alone relational database is available, the project is also developing access to the web based material through commercial course management systems like D2L and Blackboard. Interested parties can view the available instructional materials at http://genchem1.chem.okstate.edu/CCLIEMD09/BCE.php.

SCIENTIFIC INQUIRY IN CHEMISTRY LESSONS IN GERMANY AND SWEDEN - A VIDEO STUDY

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Scientific Inquiry, which illustrates one kind of scientific thinking, is formed of three stages[1]: *formulating scientific questions and hypotheses*, *planning and performing experiments* and *analysis and reflection of the data*.

Despite the fact that these three steps play a central role in science education, in reality they occur rather rarely.[2] These results point to an increased need for research in the field of *Scientific Inquiry*. This can be investigated through a comparison of countries (such as Sweden) that emphasise *Scientific Inquiry* in a stronger way than Germany, which makes culture-specific teaching processes visible.[3],[4]

The aim of the study is to analyse *Scientific Inquiry* in chemistry lessons in Germany and Sweden. The following main question is addressed in the context of this project: How is *Scientific Inquiry* organised in chemistry lessons in Germany and Sweden?

The video study will be implemented with a sample of video-recorded chemistry double lessons of 15-16-year-old students (10th grade) of grammar school classes in Berlin, Germany, and in Sweden of 15-16-year-old students (9th grade) of primary school classes. The variables of the coding manual investigate i.a. the process of *Scientific Inquiry*.

The results of the preliminary study (N=20 video-recorded lessons in Germany and Sweden) show significant differences comparing the two countries, especially on the level of *Scientific Inquiry*. To draw a conclusion chemistry lessons in Germany are more product-oriented then process-oriented. In an oral presentation these results will be discussed and put into relation in terms of consequences towards further research in the field of *Scientific Inquiry*.

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THE KINETICS OF DOUBLE CLOCK REACTION: A MODIFIED VERSION OF TRADITIONAL KINETIC EXPERIMENT FOR GRADUATE CHEMISTRY LABORATORY

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A well known and interesting experiment named as Iodine Clock Reaction (ICR) has already been used at graduate and under graduate level since last several years, to demonstrate the function of temperature on the rate of reaction (1). Some changes have been suggested to make these excellent dramatic visual reactions more interesting and accessible to the students (2-3). Here we introduced a double clock kinetic experiment based on the repeated oxidation of iodide by BrO_3^- followed by H_2O_2. The primary aim of this work is to enhance the scope of ICR experiment by some modification and extension in the existing experimental conditions with minimal chemical reagents. The proposed Iodine Double clock Reaction (IDR) has been successfully employed on the determination of the activation energies of two successive reactions in a single experimental setup. The obtained values of activation energies are 24.07 kJ mol^{-1} and 33.63 kJ mol^{-1} and Arrhenius factors are 2.65 x 10^5 and 1.17 x 10^7 for BrO_3^- and H_2O_2 respectively. The obtained data will be helpful to put forward the comparative reaction mechanisms of the reactions.

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THE TEACHING-LEARNING OF CHEMISTRY IN HIGH SCHOOL MOROCCAN: OBSTACLES AND AREAS FOR IMPROVEMENT

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Our research is at the crossroads of educational research conducted on education systems and lines of improvement. We are interested in teaching and learning of chemistry, one of the most important disciplines that contribute to the scientific training of students.

Our thinking is essentially based on: literature searchs, the findings of our field studies and our experience as a teacher of physics and chemistry.

The obstacles, that we faced, assume almost all components of the teaching-learning system and the different priorities for their improvement revolve around the following vectors: improving curriculum content and textbooks, improving the language used in teaching chemistry, orientation of teaching chemistry to an experimental approach, changing thoughts on chemicals and teacher training and «promotion» of their profession.

And therefore it is critical to build collaboration and coordination of efforts of all partners in the education system and teaching-learning of chemistry in high schools in Morocco.

Keywords: obstacles, chemistry, teaching-learning.

STUDENTS' QUESTIONS: A POTENTIAL RESOURCE FOR CHARACTERIZING STUDENTS' INTEREST IN CHEMISTRY

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The worldwide concern towards declining interest in science among students is emphasized by many researchers. One of the reasons for this decline might be that the science education community has placed more emphasis on 'what students should know about science' but not on 'what students are interested in knowing about science'[1,2.] Exploring students' interest in science in informal settings would inform classroom science teaching and also enhance the attractiveness and relevance of science curricula to students3. Student-generated questions provide insights into the world of the student and give a guide to what the student wants to know4.

Bearing these in mind, this study aims to classify the chemistry questions submitted to a national 'ask a scientist' website with respect to field of interest in chemistry, type of requested information in the question and motivation for asking the question, and to determine whether there are differences in these aspects between females' and males' questions. In order to achieve this aim, 624 self-generated chemistry questions, submitted to the application 'You're Curious About' in the website of Journal of Science and Technology, were analysed based on the coding schemes developed by Baram-Tsabari and Yarden3.

Analysis revealed there were obvious differences in the number of questions asked by females (22.8%) and males (77.2%). However; significant gender differences were not observed in the field of interest in chemistry, type of information requested in the question, and motivation for asking the question in terms of gender. The analysis regarding type of requested information in the question indicated that submitters mostly requested factual information (%46) and explanatory information (%40). Motivation to ask a question was inferred from the question, and was generally not related to direct and/or personal application (8% applicative, 92% non-applicative). For the coding scheme 'Field of interest'; categorization was based on the subject titles of the book written by Ebbing and Gammon5. The results of this coding scheme showed that the most interesting category was 'Atomic and Molecular Structure' (25%). The findings of the study might be of interest to a myriad of science educators since the results of the study shed light on what students are interested in knowing about chemistry.

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SCIENTIFIC EXPERIMENTS IN EARLY CHILDHOOD EDUCATION – EVALUATION OF DIFFERENT LEARNING OPPORTUNITIES

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Pre-school students are not scientifically illiterate[1]. Due to such findings, there is a trend in the natural sciences: the creation of learning opportunities by means of teaching scientific subject-matters to pre-school students[2]. Conducting small experiments is a key method in this context. Despite this development there is a lack of information about how the learning opportunities must be structured for pre-school students in order to be most efficient. Studies in primary schools show that students benefit significantly from structure concerning the increase of knowledge[3]. Whether these findings can be copied to the kindergartens remains to be proven.

The goal of the presented study was to gain knowledge about the impact of scientific experiments on the competencies of pre-school students. Three different learning opportunities were investigated, which differed in the degree of autonomy of the children as well as the role of the nursery staff. They all had in common that over a period of two weeks five to seven pre-school students conducted the same experiments for about 45 minutes, based on identical worksheets. In the first learning opportunity every day the pre-school students conducted the experiments under the guidance of a nursery school teacher, who structured the proceedings of the children. In the second learning opportunity the pre-school students conducted the experiments on their own and the nursery school teacher was located in the room as a reference person. In the third learning opportunity both offers changed daily.

The study shows not only that pre-school students are generally capable of gaining competencies through such scientific experiments, but also that pre-school students therefore need instructions from a nursery school teacher, though the structure does not have to present daily. The main study involved twelve nursery schools with 221 pre-school students.

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STUDENT-CENTRED ACTIVITIES PROMOTING EUROPEAN SCIENTIFIC CITIZENSHIP: SUMMER SCHOOLS AND CONTESTS

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Intensive Schools in Conservation Science

The Intensive Schools on Conservation Science are dealing with the physicochemical aspects of cultural heritage preservation, and mainly addressed to 2nd and 3rd cycle science students, as well as active professionals, wishing to acquire a solid knowledge on the ways natural and material sciences are applied in the safeguarding and authentication of tangible works of art.

A multinational team of experts from Erasmus and Tempus countries are delivering theoretical and hands-on lectures on important aspects of conservation science, covering both basic information and research case studies. The practical courses dealt with both simulation of ancient methodologies and acquaintance with modern instrumental analytical techniques, including laser field exercises. All lectures were held in English.

Intensive Schools on Conservation Science has been carried out in Teruel (Aragon, Spain). The previous editions were held, Ist in Thessaloniki (Greece, 2007), 2nd in Palermo (Italy, 2008), 3rd inThessaloniki (Greece, 2009), 4th in Teruel (Spain, 2010) and 5th in Istanbul (Turky, 2011).

The Schools were attended as average by 50 students (from 11-13 European and Tempus countries) selected out of 150 applicants.

The 1st Summer School on Conservation and Restoration of Metallic Materials was held in Genova, Italy, on September 2-8th 2011 and focused on:

- introduction to metallic materials, considering the history of the artefacts and the importance of their conservation to our cultural heritage;
- overview on techniques used to investigate metallic materials with discussions and practical experiments in the laboratory;
- special sessions in "the field" using portable equipment (e.g. Metallographic replica, XRF, XRD) to characterize metallic materials.

Some numbers:17 Lecturers from 6 Countries, 50 hours distributed on 6 days, 24 Students selected from 45 submissions from 12 European Countries, 5 Case studies used as evaluation tests for students.

Student Contests

The project involved a two-step contest (first national then multinational) to award the best students and young chemists producing an original product (written story, power point, video, strip cartoons, poster, etc..) presenting to different audiences (to primary, middle schools, high schools, university students and to the general public) the solutions that chemistry is able to provide to free choice sectors of modern society (energy, food, health, water, transport, new technologies, etc.).

Competition among students was open to students of Chemistry, Industrial Chemistry and Chemical Engineering I, II, III cycle and high school students. The participating countries were: Austria, France, Greece, Italy, Poland, and Spain.

The original products posted to a web page prepared by the University of Salonicco (Greece) for all the participating countries except Poland having an own personal web site where the voting was made. Each country awarded the 6 most voted works and selected 3 artworks for the multinational step. The 14 national finalists received 588 votes. The authors of the 3 top rated work (one author to award-winning work) will receive a diploma and will be invited to attend the EC2E2N General Assembly and their expenses totally charged to the EC2E2N.

WHAT IS THE ROLE OF "TEACHING" IN TEACHING CHEMISTRY IN HIGH SCHOOL?

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The question may seem like nonsense at a first sight, but a deeper look reveals that is poses an important issue that has been neglected at the core of some current discussions that have mainly arisen since the notion of the teacher-researcher gained space in the scenery of Science Education back in the nineties.

If it is clearly agreed that teaching Chemistry should go far beyond a mere transmission of knowledge and a dumb submission to a preordered script, as it is so common in traditional school laboratory activities, for example, the notion that "the traditional descriptions of both teachers and researchers change. Teacher-researchers raise questions about what they think and observe about their teaching and their students' learning. They collect student work in order to evaluate performance, but they also see student work as data to analyze in order to examine the teaching and learning that produced it" (1) is quite welcome. However, how far are the activities of teaching, meaning not only but also the choice of appropriate tools, methods, techniques, contents and language to be regarded as of minor importance when compared with the so-acclaimed virtues of a generic scientific research?

Assuming that research on teacher´s work turns out to be of fundamental importance so as to overcome a restrictive view of teaching as the mere transmission of knowledge, but that the nature of research is not absolute, as long as it possesses different aims, practices and conceptions, it is absolutely necessary to define what kind of research is being referred to when addressing a teacher-researcher activity, regarding who, in what circumstance and for what purposes such research is carried out, so as to avoid misconceptions and risks.

An example is a sort of scientific research that overwhelms teaching activities, a belief that has inspired a direct transposition of ordinary scientific routine into school classrooms, as a means of counteracting poor scientific formation of students, as if no differences between school knowledge and scientific knowledge existed at all. This is particularly serious where both the formation of teachers of Chemistry and that of Chemists share the same institution, as it is in Universidade Federal do Rio de Janeiro, Brazil. A more privileged social and academic rank occupied by Science and scientist account for a sort of deformation that privileges research to teaching, something that has important reflexes on the mentality of graduates.

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CHEMISTRY COMPETENCE BASED CURRICULA: A COMPARATIVE ANALYSIS OF THE IMPLEMENTATION IN GERMANY AND ITALY

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The introduction of chemistry competences based curricula at compulsory school level in Italy (MPI, 2010; MPI, 2007) initiated a comparison with Germany (KMK-Chemie, 2004), because the theoretical frameworks have many similarities, but the outcomes differ (OECD, 2010). The hypothesis is that, despite the similarities in the theoretical framework, the implementations in the two countries are different. Within a comparative analysis of the practical implementations the German outline has been used as a lens through which to observe the Italian one. The analysis highlighted that the German framework includes detailed descriptions of the areas of competences and learning outcomes, whereas the Italian framework and guidelines are holistic. Furthermore, it turned out that thecompetence "epistemology" is less addressed in Italy. The results induced to describe the area of competence "epistemology" systematically in order to facilitate the Italian teachers in implementing curricula that address this area.

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CHEMISTRY ... WHAT A PIZZA!!!

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With the aim of improving education, a group of teachers in our school are participating in a European project called PROFILES. As a component of the project, we have received training in the use of cooperative learning method, to include a scenario and to introduce concept maps in our teaching to help students to be aware of their learning and to utilise problem solving methods. Because we are convinced of the necessity to increase interest and active student involvement in the processes of learning and studying, we have developed a didactic module suitable for learning important concepts in Biology and Chemistry. Our idea was to develop a teaching module focussing on increasing the intrinsic motivation of students[1,2], thus overcoming students' hostility towards science which often makes it difficult for students to learn complex concepts. Through the module, we wanted to introduce our students to the study of chemistry by means of daily life phenomena.

Pizza is a food, very popular among teenagers and featuring strongly, together with pasta dishes, in Italian gastronomy. The module starts from a well-known food and seeks to analyse, from a scientific standpoint, the main chemical changes, physical and organoleptic characteristics that occur during its preparation by reflecting on the parameters that can affect the success of the final product. This activity also stimulates observation and reflection skills of students through requiring them to face a practical problem (how to make a good pizza) using a scientific method of investigation and an experimental approach.

Scientifically, this grade 10 (second year of secondary school) science (biology and chemistry) module is about fermentation and chemical reactions, while the educational goals are to increase student motivation, self-esteem and social abilities through group work and experimental work. At the end of the module, our students will present their work, improving, in this way, their communication skills. We are also developing a suitable assessment approach to positively evaluate the engagement and efforts of all of our students.

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MOTIVATIONAL SECONDARY SCIENCE EDUCATION: PROFILES IN ITALY

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The PROFILES (Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science, www.profiles-project.eu)[1] project has been initiated in Italy in several schools in the Marche region. The project promotes motivational inquiry-based science education (IBSE) by supporting science teachers to develop more effective ways to teach students, involving them in their learning. Because of the relation between a teacher's sense of efficacy and their commitment to teaching[2], it is important to sustain a long-term professional development programmes, based on the challenges of implementing student relevance in the learning of scientific subjects.

The programme for professional development includes coverage of active learning methods such as cooperative learning, the use of concept maps, scientific problem-solving plus support in the development of specially designed didactic modules for use in the classroom. The goal of the professional development is to develop teacher self-efficacy in motivational IBSE with an ultimate goal of transforming teachers into leaders, able to take ownership of the use of a socio-scientific learning environment for motivating their students in relevant science learning. The demanding task is to guide and support teachers in being able to scaffold students towards self-directed learning.

The PROFILES programme for professional development has started in seven schools, with teachers teaching a range of scientific topics. Although examples of modules developed according to the PROFILES' philosophy are available for every scientific subject, the teachers have preferred to enact their learning to develop their own teaching modules. Even though the programme started only a few months ago, one module is almost complete and others are at an advanced development stage. This demonstrates the potential importance of teacher motivation. The almost complete module 'Chemistry ... What a Pizza!!!' has been developed in collaboration between a chemistry and a biology teacher; this collaboration leading to very positive outcomes for the students. This is aided by a further goal of the programme for professional development which is to develop a professional friendship between teachers, so they can use the same teaching methods, can share the same standard for the assessment, and support each other where there are difficulties.

Acknowledgments: EC-FP7, Grant agreement no.: 266589.

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HOW MUCH ARE YOU COSTING ME!

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With the aim of improving interest and motivation in mathematics, several teachers from different schools in the Marche region are developing didactic modules to convey important concepts of the curriculum. The idea of the module "How much are you costing me!" is to involve the students in a topic vital for them: the cost of phone calls. The students work in cooperative groups, with different roles, to collect the tariff plan and the many offers from the multitude of providers. Students are involved in a modeling activity, with the objective to learn the Cartesian plan, the straight line, and the concept of function in a meaningful way. We wish to develop competences, knowledge and abilities, according to the curriculum, in a way that student find motivational and in this way be attracted to the learning of mathematics.

As it is often difficult to interest students in mathematics, we have followed the philosophy of the European project called PROFILES[1], to find ways of increasing the intrinsic motivation of students[2,3]. The idea is also to educate the students through this activity to be more aware of the use of the cell phone.

With this module, several important learning goals can be attained: comparing and selecting variables; developing mathematical models of real-world situations; making graphs of elementary functions; formalizing relationships between variables; strengthening the capacity for teamwork; using mathematics for the development of argumentation skills.

An example of work in progress. Together the students' worked on the parabola: in this experience, after minimal explanation, students were requested to develop meaningful applications of this geometric figure. Each cooperative group presented their work to the class and even the less interested students worked actively with their peers.

Acknowledgments: EC-FP7, Grant agreement no.: 266589.

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HIGH SCHOOL CHEMISTRY NIGHT: AN ANNUAL OUTREACH AND RECRUITMENT EVENT

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Saint Mary's University of Minnesota (SMU) has developed a unique formula for an annual chemistry experience for area high school chemistry students.[1] These events, called the "SMU High School Chemistry Nights," coordinate with the theme and timing of the American Chemical Society's National Chemistry Week, to build a coherent scenario presenting some chemical problems that visiting students are asked to solve as "chemical consultants" in the college laboratories. After the students have completed their experiments, their reports are graded and winning teams are announced at a final awards ceremony. These High School Chemistry Night events have enhanced the secondary-level chemistry educational experience for students in southeastern Minnesota, improved the chemistry-major-recruiting efforts of Saint Mary's University, and infused all participants--high school students and their teachers as well as SMU chemistry students and faculty--with renewed enthusiasm for chemistry and its real-world applications. The present paper communicates a succinct formula for this successful outreach and recruitment endeavor that lists some of the pitfalls to avoid and the spin-off benefits to expect, in order to make it amenable to adaptation and implementation at other institutions.

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OPEN AIR CHEMICAL EXPERIMENTS

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The Science Picnic of Polish Radio and the Copernicus Science Centre is Europe's largest outdoor event dedicated to science. It has been held every year since 1997 in Warsaw, each time attracting crowds of visitors – more than 100,000 in the course of a single day. The Science Picnic was commended by the European Commission in 2005 as one of 10 model European projects in the "Science and Society" field. The event has served as the inspiration for many other popular science initiatives, including the Copernicus Science Centre in Warsaw. Every year several institutions, including Cardinal Stefan Wyszynski University and Institute of Physical Chemistry**,** present chemical and physical experiments, dedicated to both children, as well as adults, not only for "beginners" but also "advanced" visitors. Each time we also face several question concerning the technique and philosophy of our presentations. Except for usual ones such as safety, waste disposal and other technical conditions (including the financial support), other, more general problems need to be considered e.g.

- Balance between the fun and education
- Scale [large scale experiments vs. small "hands-on suitable" ones]
- Models [the problem of explaining NMR, AFM or SEM techniques without real apparatus]
- etc.

We also get a feedback from visitors;

- Almost 90% of persons participating in this Picnic intend to visit it next year, 95% of participants are glad they came to the Picnic.
- One third of Picnic participants came from outside of Warsaw and 41% of them - outside of Mazovia region, which means that the Picnic is a nation-wide event.
- Picnic participants value strongly the possibility of meeting competent persons who have a positive approach towards the participants themselves and allow them to perform experiments without interfering.

THE COLOURS OF CHEMISTRY: THERE'S A NEW SCENT IN THE AIR, OR OLD PERCHANCE?

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Chemistry often has a weak appeal for students both in general and scientific courses. As it has been stressed along "2011 IYC", there is the urge to change such perceptions and prejudices, and the easiest way is to let young people understand how much both the quality of their lifestyle and their expectations for a better future on this planet are relying on chemistry.

Chemistry is intrinsically creative and fun, just as it was when, in the same years and from different perspectives, Perkin and Cannizzaro were founding our science as we now know it.

Textile colouration and finishing is probably the most ancient chemical technology which is still pervasive in any society; in every age it has been boosting researches, whose fallout has enriched every sector of science, technology, medicine, economy, art and politics. In recent years we have seen that hi-tech material research is often rediscovering ideas from an unbroken story of more than ten thousands years, aiming at improving sustainability and quality of life.

The thesis of this work is that it could even be possible to redesign most of the syllabus for chemistry courses at secondary level, following the thread of colour and dyeing science.

It means looking at chemical theories and interpretations not as simply learning some odd law concerning invisible things, but as a way of thinking about the origin, properties and changes of anything we literally *see* outside and inside us, from blood to food, from nail polish to sneakers.

By picking experimental suggestions from polymers and fibres, water, dyes and surfactants, colorimetry etc., students may be introduced to general, physical, organic and analytical chemistry, to material science, health & environmental issues, philosophy and ethics of science.

This work is based on the author's teaching activity in courses of many levels, from job training to undergraduate academic, with special reference to recent experiences at "Setificio", the technical high school which, since 1868, has been a core component of the "Como silk district".

Many activities of different classes (age 15 to 19) have been coordinated in a collaborative form on the ground of some common experimental work, also including peer-to-peer teaching.

The underlying theoretical framework has then been proposed to each class with respect to different advancement levels and for the aims of their own course.

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COUNTING THE CHEMICAL CONCEPTS

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Elementary calculation operations are verbalised, imitated and rehearsed until both conscious and automatic abilities are achieved in calculating masses and chemical amounts of substance in elementary stoichiometric problems. A new intermediary concept has been introduced with the purpose to lead or prepare to the *mole* as an intuitive concept.

Difficulty of students in choosing the proper way to divide or multiply chemical quantities in solving stoichiometric problems has been described and studied. Every teacher has experimented a strong frustrating and discouraging sense of inadequacy of the efforts to teach thoughtful (non-mechanical) strategies and/or the scarce reliability of automatisms based on the substitution of numbers in formulas or by means of Factor-Label like methods.

Several reasonable hypotheses have been carried out to make this issue explainable and several corresponding teaching strategies to overcome the lack of formal and proportional reasoning, as well as teaching materials have been developed. Models of particulate matter as nuts and bolts, magnets, symbolic drawings, etc. have been unsuccessfully exploited.

The hypotheses behind this experiment is that children build up spontaneous concepts as the number of apples in one kilogram neither by logics nor by arithmetic, but as the result of immersion in the implicit rules of a sort of linguistic game. Furthermore these concepts remain at the intuitive and unconscious level until the development of the systemic concept (true, scientific) structure of generalisation arises. It is important, anyway, to *prepare* the imitable "preconcepts" in such a way that they won't obstacle the subsumption, conscious, process.

Dividing the mass of a substance sample by the formula weight you get something similar to a *number* of formulas. We call this the –proportional- *number* of formulas, (molecules, atoms etc.), remaining indifferent to the lacking of measuring units. What matters is that this is psychologically a countable *number*. Moles haven't got the same sense. Too often they don't make *any* sense. The second step is comparing and verbalising similar calculations using this temporary concept. In the third step these numbers of formulas-particles of substance A are related (as equal, the double, one third and so on) to the corresponding number of formulas-particles of substance B. Finally, the easiest step is to multiplying number of B by the FW of B to get the mass of B. Verbalisations are made in every step to fix the rules of the implicit proportional reasoning.

BEGINNERS APPROACH TO CHEMISTRY IN A "MILD" INQUIRY BASED LEARNING LABORATORY CONTEXT

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The recent halving of laboratory time in the secondary State Technical Institutes in Italy has apparently impaired the possibility to exploit this resource in basic chemical education. Anyway, after one year and half of adaption to this new system, we have been compelled to re-think some aspects of laboratory as a resource, and some conditions for its effectiveness that had been overlooked in the past, because of the "abundance" of this resource.

In this abstract we can summarize the most important criteria for an effective IBSE lab program, according to the philosophy of the PROFILES project[1]. 1. Any important chemical concept should be referable to experimental evidence. 2. A few meaningful experiments should act as milestones in the path of the adapted and progressing syllabus. 3. The materials, instrumentation and context of each experiment should be presented in advance, with a preview of a certain phenomena, to illustrate the task, to elicit a focus question or investigation, and to give enough time for preparing a plan by the students, discussing vocabulary and theoretical background, and comparing the plans before of going in the laboratory. 4. Even if the laboratory is a firm anchoring reference in the development of the course, language development is more important, so it is better to defer a lab session and use time to fix and share chemical words and meanings, to rise the interest and understanding of students. Sometimes a demonstration can be done instead of a hands-on laboratory in groups. 5. Time demanding preparation activities should be avoided or pre-arranged in advance for the students by the teachers, and planning should be focused on time optimization in such a way to maximize the cognitive outcomes of the experiment. 6. Reporting and discussing after-lab should be supported by a ICT environment permitting a continuity of interactions and scaffolding tasks in school and out of school. 7. Every activity should be scaffolded and followed by imitation and practicing in the use of concepts, because of the age: the beginner students will never be able to master a complete inquiry activity and autonomous choice and use of concepts.

We mean to *prepare* the scientific-concepts construction, and not to expect straightway a mastery learning. This is the sense of adjective "mild" in front of Inquiry in the title.

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PEER-LED TEAM LEARNING (PLTL)

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PLTL[1] was created in the early 1990's at the City College of New York (CCNY) in response to the observation that students entering colleges and universities were increasingly more poorly prepared in chemistry and mathematics with the result being a dramatic increase in the percent of poor grades in general and organic chemistry and an alarming increase in the dropout rate of students from the sciences. PLTL is a partnership of faculty, learning specialists, and peer leaders who work together to help students build conceptual understanding and problem-solving skills in their science and mathematics courses. The PLTL model introduces the peer-led workshop where students work together in groups to solve challenging problems that have been designed by the faculty so as to engage them with the subject material and with each other. The workshop group is guided by an experienced leader, such as a graduate student or an undergraduate who had taken the course earlier, who has been trained to lead the workshops. In short, PLTL provides an active learning experience for the students, a leadership role for the undergraduate or graduate workshop leader, and a creative new dimension to faculty teaching. We developed conceptual, quantitative (but calculator-free), and computer-based materials for the PLTL workshops in our general chemistry course. With detailed guidance from the instructor-generated written materials and from the leaders, the students worked together for two hours each week on a succession of topics: molecular structure, stoichiometry, equilibria, titrations, solubility, gases, Maxwell-Boltzmann distribution, thermodynamics, electrochemistry, chemical kinetics and reaction mechanisms, wave interference, atomic spectra, wave functions and orbitals, bonding, quantum concepts. Although PLTL has generally been used in a college setting, this pedagogical approach may also be applied in high school by adjusting the workshop to fit the learning environment, and designing workshop materials suitable for the younger students.

Reference

1. www.pltl.org

THE NEW GUIDELINE FOR SCIENCE EDUCATION AND MICROSCALE CHEMISTRY

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Contents of Primary and secondary education in Japan are controlled by the Course of Study which is provided by Ministry of Education, Education, Culture, Sports, Science & Technology. The educational content in elementary and junior high schools had been selected until 2007 : the amount is almost one half of that 20 years before. The new Course of Study for secondary schools was revised in 2008 and has been taking effect since 2010 in junior high and in April 2012 in senior high schools. The content of science increased considerably and textbooks are much heavier than those under the previous Course of Study. Many new concepts have been introduced in textbooks of chemistry and science, and in the new textbook of high school Chemistry Basics, more state-of-the-art contents are introduced..

We have been developing microscale experiments for the new Course of Study. As microscale experiments can be performed within short time, it is suited to Japanese schools. We have developed microscale experiments on modern topics such as conductive polymers. In the presentation, such Microscale experiments will be introduced.

HIGH SCHOOL'S CHEMISTRY TEACHERS PEDAGOGICAL CONTENT KNOWLEDGE ON CHEMICAL EQUILIBRIUM

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Chemical equilibrium is a central concept in the teaching and learning of chemistry and it remains as one of the most difficult for students and teachers[1]. Although its importance, there are few articles about the pedagogical content knowledge (PCK) of this concept[2] and, in the past years, teacher educators and educational researchers have emphasized the need to develop the teachers' PCK, as a useful tool to enhance learning and to train pre-service teachers[3,4].

In this study we documented and portrayed the PCK of four high school Mexican General Chemistry teachers in this topic. Three of them have a master's degree in chemical education and the fourth also has a master but in organic chemistry.

To document PCK, we decided to use the methodology of the Content Representation (CoRe) proposed by Loughran *et al.* The CoRe questionnaire was constructed with five questions (Importance of the topic; difficulties for teaching and learning it; teaching procedures used to engage students; and ways to assess it) and the following four central ideas, which teachers identified consensually as the core of understanding and teaching: Previous knowledge; Reversibility and dynamic equilibrium; Equilibrium constant; and factors affecting chemical equilibrium.

The analysis of the CoRes will be presented. Summarizing, 1) Teachers consider the abstraction of the central concepts as the most important challenge for teaching and learning the topic; 2) Students usually do not conceive simultaneous forward and backwards reaction processes, they assume that the forward reaction ends first and then the process reverses; 3) More common teaching procedures are experiments and analogies (the most mentioned was that of liquid transfer between containers); 4) Ordinary tests are still the form of knowledge assessment; 5) Of note is the fact that no use is made of teaching-learning sequences and also that the kinetic arguments are still the framework of the concept construction, not the thermodynamics ones.

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GREEN CHEMISTRY IN SECONDARY SCHOOL CHEMISTRY CURRICULUM AND CHEMISTRY TEACHING METHODS COURSE

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Green Chemistry refers to the practices that reduce the use of hazardous and nonhazardous materials, energy, water, or other resources as well as protect natural resources through efficient use (EPA, 1996). The implementation of the green chemistry into practice is guided by 12 principles that underlie a green approach to chemistry (Anastas and Warner, 1998). Through application and extension of these 12 principles, green chemistry can contribute to sustainable development (Wardencki *et al.*, 2005). In schools, green chemistry allows students to make connections between the discipline of chemistry, other disciplinary subject matters, and aspects of their lives. Our effort integrating green chemistry into the teaching methods course constitutes a concrete implementation of the university's sustainability endeavors. The purpose of this paper is to describe the green chemistry approach we used in the secondary school chemistry curriculum and in chemistry teaching methods courses as an example of a "good/effective" practice, evidence for which our experimental work has provided (e.g., Karpudewan, et al., 2009, 2011; Karpudewan, Ismail and Roth, 2011, in press).

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THE IPAD PROJECT: INTEGRATING IPADS INTO GENERAL CHEMISTRY

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Interactive technology in the classroom has been shown to enhance student learning. But being the first to implement new technology on your campus can be a demanding task. The Apple iPad is one of the most exciting innovations of modern technology and has tremendous potential as a teaching tool. But, is there an app for that? Does interacting with an iPad in a general chemistry classroom environment actually promote student learning?

Using available iPad applications, we designed and implemented structured activities in a first semester general chemistry class for science majors. These activities introduced, reinforced, or practiced standard topics such as nomenclature and stoichiometry. Several forms of student assessment were implemented to gauge perspective and evaluate outcomes. A preliminary analysis of these assessments will be presented.

Begun in Fall 2010, the iPad Project involved purchasing and setting-up a dozen iPads with apps; this has proven a time-consuming challenge. Our project ideas also required wireless network access, a HD projector and AppleTV, all of which required resourceful configuration. Once the iPads were configured and put into the hands of the students, additional lessons were learned related to distributing and collecting assignments. In this presentation, examples of classroom activities will be described and demonstrated. Student perceptions of this technology and its benefits were assessed pre- and post-semester and the results from these surveys will be discussed. After successfully overcoming the obstacles, I present here a perspective on project logistics and valuable lessons learned.

TEACHING HIGH SCHOOL CHEMISTRY IN THE 21ST CENTURY

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Chemistry teaching has witnessed significant changes in pedagogical approach and delivery over the last few decades. Teachers now need to incorporate into their lessons not only the Johnstone (1) 3-D view (macro, representational and molecular) but also the 4th dimension proposed by Mahaffy (2) involving the impact of chemistry on society and the environment. Teachers also need to be aware of the known (3) misconceptions (or alternative views) that students bring to their classrooms and use appropriate analogies, demonstrations, interactive exercises and discussion to move student understanding towards the desired scientifically literate view.

Technological developments and the introduction of high quality Flash (4) or Java (5) animations have helped students "see" the invisible world of chemistry and high definition video is becoming the norm. Experienced teachers have a "guild of knowledge" based on feedback from their lessons over many years and researchers such as Bucat (6) have highlighted the importance of this Pedagogical Content Knowledge (PCK).

This presentation will illustrate one way in which high schools teachers can incorporate and coordinate appropriate resources which address these issues and which can be easily shared between teachers. Examples using Powerpoint 2010 will be used to illustrate how interactive animations, video clips, 3-D molecular views and notes can all be incorporated into a single file that meets all of these pedagogical requirements.

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ANALYSING THE MISTAKES MADE BY NEW ZEALAND YEAR 13 STUDENTS USING BESTCHOICE CHEMISTRY TUTORIAL WEBSITE

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Bestchoice is a website designed for assisting students to gain an understanding of chemistry and is used extensively by Year 12 and Year 13 New Zealand students. It is designed to scaffold learning by imitating expert – novice type interactions and to provide strategies for solving quantitative problems. As a web-based learning tool, *Bestchoice* stores all data related to the responses by users in a database that can then be analysed for patterns of responses in order to identify whether misconceptions for particular chemistry concepts are prevalent in certain student cohorts.

This project analysed the responses made by New Zealand Year 13 students for the Shells and Subshells module that assesses concepts of atomic theory relevant to Achievement Standard 3.4 *Describe properties of particles and thermochemical principles*. The incorrect responses to the text-entered questions presented in this module were coded into several categories that allowed explanations to be proposed for prevalent mistakes students. Statistical significance was also used to highlight wrong choice preference for multi-choice questions. The findings of this research aid in improving the design of the *Bestchoice* website as well as inform teachers of the areas that may require greater attention when teaching atomic theory.

TEACHING CHEMISTRY THROUGH INQUIRY – IN-SERVICE TEACHER PROGRAMME

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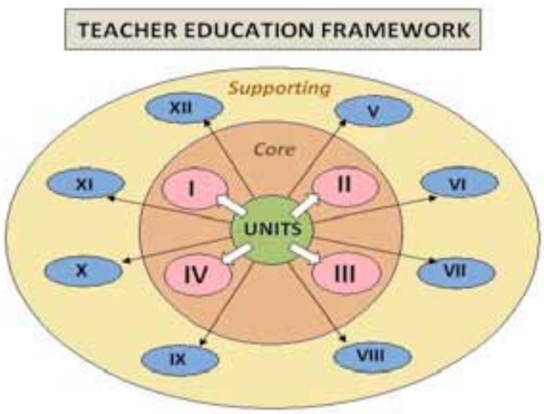
Inquiry based teaching changes the traditional role of the instructor to that of a facilitator of learning. Teachers "create an environment in which they and students work together as active learners" and orchestrate learning so that students are engaged, focussed and challenged throughout each class (National Research Council, 1996)[1]. Posing questions and problems that are relevant to students' lives are core to the process. According to Driver et al. (1994 cited in Crawford, 2000)[2] inquiry teachers assist the improvement of students' current knowledge by encouraging students' involvement in hands on activities relevant to real world phenomena and "engaging in higher level thinking and problem solving". In turn, there is a shift from teacher centred to more student centred classrooms.

Making the transfer from traditional teaching roles to constructivist teaching roles can be a difficult process for in-service teachers. Three key factors that influence the use of inquiry in the classroom by a teacher are their personal beliefs, confidence in scientific knowledge and confidence in dealing with uncertainty.

Using materials developed for inquiry learning in Chemistry through EU FP7 project, ESTABLISH[3], workshops for in-service teachers have been developed that address these issues. Key to the process of teacher change is the need for teachers to experience real inquiry within the in-service workshops and implement in their classrooms and then to be supported in their development of new materials. The framework developed for in-service teachers focusses on these core elements and also allows for flexibility and cultural variations through provision of supporting elements. This framework will be presented within the context of the chemistry teacher education.



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PROFILES CONTINUOUS PROFESSIONAL DEVELOPMENT WORKSHOP OF CHEMISTRY TEACHERS: THE ISRAELI EXPERIENCE

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A year round face to face and an on-line workshop focusing on teachers' professional development was conducted in Israel. The program and conclusions from the workshop will be elaborated and described in the ICCE 2012 presentation. The professional development (CPD) workshop was based on PROFILES rationale which aims to promote inquiry based science education (IBSE) through enhancing the self-efficacy and ownership of chemistry teachers. In order to reach these goals, the workshop included four main stages: (a) learning the spirit of PROFILES by performing an existing module (acting as a learner), (b) designing and developing a new module which is relevant to the teacher's class and environment, (c) implementing the module in class, and (d) reflecting all along the path. The program provided the teachers with an opportunity to play different roles as the CPD workshop progressed. The teachers acted as *learners* when they performed an existing module and got acquainted with the ideas of PROFILES, and as *curriculum developers* when they designed a new module. The modules deal with various topics such as alcohol beverages, biodiesel, sunscreen, drinking water, Ritalin, plastics, etc. During the workshop, the teachers had to write, reflect, and describe their experiences in various formats (the teacher as a *reflective practitioner*). This procedure helped the teachers to reflect, and revise the module after its implementation in class. Teachers, who developed creative scientific problem-solving modules related to socio-scientific decision-making issues, were proud and improved their skills. The reflection helped the CPD providers to receive feedback from the teachers. We analyzed the text and found evidence which showed the development of the teachers as *curriculum designers, as reflective teachers and as leaders* (Mamlok-Naaman, Blonder, & Hofstein, 2010). We could notice different signs of self-efficacy and ownership development. Teachers' professional development is essential for school science teaching to become more meaningful, more inquiry-based, and better related to the 21st century science and socio-scientific issues.

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ASPECTS RELATED TO THE CONTINUOUS PROFESSIONAL DEVELOPMENT OF CHEMISTRY TEACHERS STATED IN THE FRAME OF PROFILES TRAINING PROGRAM

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In Romania, the teaching career represents an important objective of the *National Strategy of Development*, being strong related to the training process of the school personnel. It is important to emphasize that during the last years it was imposed moreover the need of continuously training of the teachers, both on theoretical and practical aspects. In fact, the success of the reforming process (in primary and secondary Romanian education system) depends on the continuously teachers' professional development, especially done in the frame of several programs who aim to gain specific competences for teachers.

In this sense, the "*PROFILES - Education through Sciences*" training program is oriented on the improving of teaching activities, being organized in the frame of the European Project "*PROFILES – Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science*" (code: 5.2.2.1-SiS-2010-2.2.1-266589), which has as objective to promote reflection-oriented teaching - where this enhances students' scientific literacy -, and to design a collaborative network, able to offer to Science teaches and researchers the possibility of active cooperation by promoting ideas and specific training materials, spreading the best practices, seminaries, workshops etc.

In this sense, the mentioned training program was developed and accredited - at national level - with the declared aim to response to a clear necessity for Romanian Science teachers on promoting training reflection-oriented, pedagogical and scientific competences, *Inquiry-based Science Education* (*IBSE*) and related approaches which can be implemented in the educational environment. At the same time, the proposed training program, answered to the conclusions of the curricular *Delphi Study*, performed in the frame of *PROFILES* project, that involved in Romania more than 100 stakeholders in reflecting on contents and aims of Science Education as well as in outlining aspects and approaches of modern Science Education.

The present paper illustrates the main aspects of the PROFILES continuous professional development in Romania, its specific background and components, as well as two examples of proposed conceptual framework (Modules) for teaching Chemistry / Science at secondary level, based on the *PROFILES* model.

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USING THE NEW CHEMSOURCE TO IMPROVE QUESTIONING SKILLS

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The art of questioning is central to secondary science instruction. Teachers have always used questions in a variety of ways--to focus learning, to find out what students know and are able to do, and to guide undestanding. Questions, particularly those that focus on higher level thinking skills, are an important part of formative assessment which has been shown to improve student achievement. [1] Quality questioning, just as any other part of instruction must be planned in order to engage all students in understanding the desired content. Students must be taught to ask relevant and probing questions. Instructors must be prepared to field these questions and stimulate further deep thinking. [2]

Although higher level questions have always been desired as a part of instruction in effective classrooms, there isn't always a source of guidance for chemistry teachers to consult to plan questions with maximum impact. SourceBook (orignially published in 1987) has always included suggestions for teacher-student interaction prior to, during, and after laboratory activities. Good sources for relevant and probing questions are the sections of SourceBook devoted to student misconceptions, discussion activities, and frequently asked questions, as well as pre- and post- laboratory questions. The New ChemSource[3] includes several new or adapted laboratory activities complete with additional questions. Examples from each of these sections will be examined. A teacher wishing to increase their competence in this important aspect of chemistry teaching can not only locate useful questions but also can learn to adapt questions to lead to greater student achievement.

Handouts for this paper can be accessed at www.chemsource.info.

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DO UK SECONDARY CHEMISTRY TEACHERS HAVE BETTER UNDERSTANDING THAN PHYSICS AND BIOLOGY TEACHERS?

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Teachers are expected to have adequate personal subject knowledge; traditionally a science degree subject has been accepted as a good indicator. Our experience, shared by many colleagues, led us to question this assumption, since we noted some common errors in classroom teaching, even by specialists teaching their own subject. As an alternative, we chose questions from higher tier public examinations, taken at age 16+, and designed to assess different topics in chemistry, physics and biology. We chose this test because, at present, all secondary science teachers in England have to be able to teach at this level across all the sciences. 88 graduates took the test at the course start and 74 at the course end. The questions were answered under test conditions and marked against the official mark scheme. Data was recorded question by question, with some personal data such as gender, degree subject and grade, and university, in an anonymised form. The analysis took the form of computing mean grades for each different degree discipline and for each separate subject of the questions. Following this, to explore how the graduates answered specific questions, we asked selected individuals to answer them while making a commentary on what was in their mind, the Think Aloud Protocol, which was audio recorded and analysed by the group of researchers.

The results showed all groups failed to score well to start with, but improved as their 10 month teacher training course was completed. Chemists and physicists reached very good level in questions relating to their degree. Chemists appeared to be stronger in all the sciences, compared with their colleagues, while the biologists found the questions more difficult to answer, even in their own discipline. Physicists were very good at answering chemistry questions, and even good at answering biology questions, a subject they had only studied to age 16+. We found no pattern in gender differences, grade of degree or type of university, and none when individual questions were analysed.

The Think Aloud Protocol proved valuable in showing how these teachers answered the questions, often by memory of routines learned without recourse to subject knowledge. Further exploration of how these teachers teach their students how to respond to these questions will shed further light on the application of their subject knowledge in further research.

Details of the evidence will be presented at the Conference. This work has implications for teaching subject knowledge of graduates in teacher training.

ANALYZING CHEMISTRY TEACHERS' PROGRESS IN PLANNING EXPERIMENTAL INQUIRY-BASED ACTIVITIES

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Despite the preference for inquiry based laboratory experiments models', many chemistry teachers in Brazil report the use of more traditional approach on their class activities[1.] Some of them claimed the lack of experience in planning inquire based activities, since they were not introduced to this approach either in undergraduate course or in teachers in service programs.

The purpose of this study was to investigate how chemistry teachers plan inquiry-based activities and pose questions to the students aiming to promote higher order thinking skills. An in-service course was offered to 20 chemistry teachers from some public schools of the city of Diadema, São Paulo, Brazil. It consisted of eight four-hour meetings in which the teachers got background in developing inquiry laboratory activities[2,] and planned tree activities. These plans were analyzed according to some characteristics of inquiry lab activities, such as problem situation, pre-lab activities, pos-lab activities, collecting, recording and analysis of data. The questions posed by the teachers were analyzed considering Zollers' proposals of cognitive skills levels3. The teachers engaged in this research consisted of a group of eight teachers who completed all the proposed activities.

By comparing the initial plans with the last ones, some improvements could be noted. The first plan did not present a problem to be investigated by the students; the experimental results were not proposed to be discussed in the class. The experiment aimed to prove theories already taught.

The final plan revealed an inquiry based approach, a problem to be investigated by the students was proposed, and they were asked to make conclusions achieving ,in this way, new knowledge. While the initial plans presented no questions to explore the collected data, in the final ones the teachers posed questions which demanded lower order cognitive skills as well as higher ones. Although the lesson plans have not reached a higher level of inquiry elaboration, we consider that some of the teachers made remarkable progress on their proposals.

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IN-SERVICE TRAINING OF CHEMISTRY TEACHERS: THE USE OF MULTIMEDIA IN TEACHING CHEMISTRY

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The accelerated development of information and communication technologies followed by several studies in the cognitive theory area, have promoted the construction of many visual tools (statics virtual 2D and pseudo-3D images, simulations, animations, interactive software's, etc) that have been available to educators. Multimedia can provide one method to describe how a particular component in a complex mechanism interacts, especially in dynamic sub micro systems that cannot be observed, and also to provide opportunities for interpretation, discussion, reasoning and reflection that are very important to knowledge building. Nevertheless this beliefs, there are some problematic issues to address with the use of visualizations. How is a visual representation turned into knowledge (Rapp, 2007)? Others concerns are related to the design of the multimedia tools that are now very accessible to educators (Wu, 2004), and another trend of research deals with the education that teachers must have to be prepared to teach in this new environment (Newton & Rogers, 2001). With our research we aimed to investigate how in-service teachers (n=14) enrolled in a teachers' training course of 40h, understand the nature and the role of these tools in science teaching as well as the impact of this training. The training course exposed them the learning theories (sociocultural and cognitive) that can support the use of visualizations, especially multimedia environments. During the training teachers were invited to build in group teaching learning sequences (TLS) about some science content using multimedia tools. At the beginning a questionnaire to identify some previous conceptions on this issue have been applied and analyzed. On a later stage it was analyzed the TLS made by them and the audiovisual record of their oral communications to the class. It was also analyzed the final semi-structured interview with these teachers' groups. As main result we highlight a development of the knowledge about these tools, especially on the impact of the visual language on apprenticeship and on the notion of scientific model. We could also observe a change on the reasons and criterion to use these tools. According our findings we can say that the training has expanded the teachers' initial notion of models and the theoretical background that support the use of this visual resources which was reflected on theirs TLS.

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TRAINING CHEMISTRY TEACHERS IN EDUCATION FOR SUSTAINABLE DEVELOPMENT

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Chemistry plays a central role in the sustainable development of any industrialized society (1). But education is also considered to be a crucial factor for sustainable development. This is the reason why the UN has announced the years between 2005 and 2014 to be the global decade for Education for Sustainable Development (ESD) (2). In connection with both claims, Chemistry education must thoroughly contribute to ESD. It should enable students to learn about the role and importance of Chemistry for sustainable development, e.g. the concept of Green Chemistry or the handling of socio-scientific issues related to the application of Chemistry-related technologies (3). Yet studies undertaken in Germany on the content knowledge and PCK of (student) teachers concerning Green Chemistry and ESD revealed a severe lack of knowledge (4). This is the reason why a module has been developed to better train prospective Chemistry teachers in the concepts of Green Chemistry and ESD. The module consists of several different parts. The first deals with the scientific basics of sustainability theories and the principles of Green Chemistry which incorporate the WebQuest structure. The second uses cooperative learning in a jigsaw classroom about the essential theoretical and legal resources for operating ESD in German Chemistry classrooms. With regard to the practical application of ESD, a specifically-designed lesson plan for this purpose based on the evaluation of plastics (5) is analysed and essential parts of the lesson plan are mimicked by the students. Optional additions include confrontation by further teaching materials, e.g. a board game based on Green Chemistry.

The entire module is followed up by two questionnaires. These questionnaires make prior knowledge and attitudes in the learner explicit and evaluate (student) teachers' views of the content learned. Both questionnaires have been employed for the cyclical development of this module and for further evaluation purposes. The presentation will give an overview of the development and evaluation of the module.

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DEVELOPING SKILLS IN TRANSFORMING SCIENTIFIC AND EDUCATIONAL RESEARCH INTO PRACTICE AS PART OF CHEMISTRY TEACHER TRAINING

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Teachers are the gatekeepers for future scientists and engineers. It is important that we equip science teachers with the appropriate skills to keep up-to-date with current science and be able to transform science education research (SER) into effective practice. This paper describes some of the teaching, learning and assessment methods utilised in a chemistry pedagogics module in our university. The aim of this module is to develop pedagogical content knowledge (PCK); it does not have a strict curriculum and is flexible in order to meet the trainee teachers' needs and address areas of difficulty. There is no terminal examination and students are assessed on four assignments. These assignments are chosen to develop the students' scientific literacy, increase their confidence in turning science education research (SER) into effective practice and provide future sharable resources. The assignments allow the students to become involved in an ongoing community of shared practice and to apply research ideas to their own teaching methodologies. This paper aims to show how a flexible curriculum and assessment technique can be used to connect students' skills and knowledge from many areas, using SER, and to integrate it into their own teaching and learning. Formal science education does not always appear to explicitly develop critical and creative thinking skills, both of which are important in the work of a scientist. Neither does it always develop scientific literacy[1,2], with many colleges and universities sharing the same *"dirty little secret: we are all turning out scientifically illiterate students"*[3]. The course has thus developed a number of themes and assignments which develop transferable skills, so that the students are equipped to be flexible and adaptable teachers when they graduate. Our goal is to produce science teachers as innovators and problem-solvers. The premise of *"Give a man a fish and you feed him for a day. Teach a man to fish and you feed him for a lifetime"* (Chinese proverb) has guided this course. The experiences and opinions of the pre-service science teachers will be presented in this paper, highlighting the benefits of incorporating SER into a pre-service chemistry course.

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FOLLOWING NOVICE TEACHERS: THE DEVELOPMENT OF PCK FROM STUDENT TO A CHEMISTRY TEACHER

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A series of research refers to the study of the development of knowledge necessary for a teacher, encompassing content, pedagogical and context knowledge. With similar relevance, the discussion between pre-service and in-service education has been approached to propose training curricula that can increasingly contribute to the formation of reflective practitioners. The concept of Pedagogical Content Knowledge (PCK) was initially proposed by Shulman (1987)[1], and it has been extended from the initial understanding referred to *a set of knowledge that go beyond the content knowledge and include the content representation and their selection, the examples and analogies* to the one in which points the PCK as the *knowledge that teachers use during the teaching process*[2]. In this paper we follow the development of PCK of three student teachers from their last year training and the early years of work as teachers of chemistry in high school and college. Our data involve written activities, recordings of classes taught and reflections of undergraduates who attended Methodology for Teaching Chemistry course, along with interviews and audio recordings of classroom teachers of chemistry in their real contexts after a period ranging from three to five years after graduation. We use instruments CoRe (Content Representation) and PaP-ers (Pedagogical and Professional experience Repertoires) to document the practice of teachers. We relate some aspects in the teacher discourse to the Model of Pedagogical Reasoning and Action from Shulman and to the teacher knowledge components from Morine-Dershimer and Kent. We also use the tool of discourse analysis proposed by Mortimer and Scott to identify patterns of interaction. In the investigated teachers, the development of PCK was promoted during pre-service training experience through planning and intervention in the classroom and activities that sought to stimulate reflection. Still, we can infer that the lack of **knowledge of learners and difficulties**, the **curriculum** and the **specific contexts** are factors that directly influence these teachers' PCK and that are factors that are directly related to the experience. The data after three years of professional experience reveal an improvement in PCK. From the analysis carried out, we emphasize the need to act in these early years of professional experience through collaborative groups, aiming to contribute more directly to the development of PCK.

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TEACHING CERTIFICATE PROGRAM AT THE WEIZMANN INSTITUTE OF SCIENCE IN ISRAEL

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A few years ago, a program of in-service training was launched at the Weizmann Institute of Science. The program is aimed at graduate and post-graduate students of the Weizmann Institute, and consists of: (1) six courses of one semester: Introduction to science education (Mamlok-Namman & Eilks, in press); learning environments; assessment; educational psychology; history and philosophy of science (Mamlok-Naaman, Ben-Zvi, Hofstein, Menis & Erduran, 2005); special issues in teaching and learning, (2) Two didactic courses focusing on the chosen discipline (e.g., biology, chemistry, physics), and (3) 180 hours of practical work. This course will focus on topics such as: Goals and reforms in science education; teaching strategies (e.g., inquiry-type experiments, argumentation, group work, web-based learning and guided reading of scientific articles); scientific literacy. cognitive and affective aspects in students' learning (e.g., misconceptions); alternative assessment of students. In our presentation, we will elaborate on the contents of the "Introduction to science education" course, and on the didactic course in chemistry. The "Introduction to science education" course focuses on topics such as: Goals and reforms in science education; teaching strategies (e.g., inquiry-type experiments, argumentation, group work, web-based learning and guided reading of scientific articles); scientific literacy; cognitive and affective aspects in students' learning (e.g., misconceptions); alternative assessment of students. The Chemistry didactic workshops focuses on topics from the national high school chemistry new curriculum. Those topics are discussed in the framework of strategies for teaching chemistry in high school: inquiry-type experiments, argumentation, group work, web-based learning and guided reading of scientific articles. In addition, we deal with misconception related to bonding and structure, teaching planning and alternative assessment (Mamlok-Naamn, Hofstein & Penick, 2007).

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‘INTERPRETIVE FRAMEWORKS’ SUPPORTING ARGUMENTATION PROCESSES IN PRE-SERVICE CHEMISTRY TEACHERS: THE ROLE OF META-THEORETICAL IDEAS

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This paper presents results of the analysis of part of the corpus of data generated in an exploratory investigation conducted by one of the authors. In the original piece of research, two ‘interpretative frameworks’ were proposed in order to analyse fundamental issues selected by science teachers when envolved in argumentation processes. An interpretive framework is here understood as a referential aspect that *guides* an argumentation process, providing a sort of model through which the evidence is read. Two interpretive frameworks were identified so far: *instructional ideas* and *common sense ideas*. In this paper we add a *meta-theoretical* perspective to the analysis, considering the ideas about science employed by teachers when arguing. The methodology of the original piece of research included: 1. participation of a group of pre-service teachers in a video game with science content, *Kokori*[1]; 2. application of post-game survey and semi-structured interview; 3. preliminary analysis of the results obtained (via constant comparative method) in terms of the two original interpretive frameworks. In this paper, we discuss and re-interpret selected fragments from the interviews conducted with chemistry teachers; we focus on a third interpretive framework of meta-theoretical character. The addition of this new perspective allowed us to characterise teachers’ argumentation processes through two key ideas coming from philosophical reflection on science; such ideas can be technically characterised as *representation* (the way in which science ‘captures’ reality with symbolic artifacts), and *correspondence* (the relationship between what science ‘predicates’ and reality). Results of our re-interpretation lead us to consider that chemistry teachers often rely on these two meta-theoretical ideas when developing argumentative processes, since they talk about the complex, interactive relationships between symbolic entities and the phenomena modelled.

Reference

1. The game Kokori simulates an environment representing the animal cell; it inspects cell functions related to key biological processes in different situations: the attack of a bacterium, a virus invasion, lack of energy, etc.

TY SCIENCE: CURRICULUM DEVELOPMENT INVOLVING TRAINEE SCIENCE TEACHERS

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The Irish Transition Year Programme (TYP) is an optional year between the junior and senior second-level cycles, taken by just over 50% of pupils. It is a curriculum-free year with no examinations and schools and teachers are free to use the year as they see fit, providing they meet the official guidelines[1]. TYP offers science teachers a great opportunity to innovate and develop their own science course; however, in reality very few teachers have the time or energy to develop their own materials. Recent research shows that in practice most teachers teach from the senior cycle science syllabi[2]. The TY Science project was started in 2003 using an Action Research model to develop novel curriculum materials for use during the TYP. The model involves 4th year science education students developing teaching modules for their final year projects, which involve the design, implementation and evaluation of an eight-week module. The TY Science modules follow a set of design principles and a common format: they have a single interdisciplinary theme e.g. Environmental Science, structured into eight week-long units, covering 2 single and 1 double class periods. The materials are provided in the form of a Pupil Workbook and a Teacher's Handbook. The themes are chosen with a strong STS focus, they are context-based, build on the junior cycle science course, and aim to develop the pupil's laboratory, communication and IT skills, with an emphasis on inquiry-based pupil activities. The design, implementation and evaluation of three modules will be described: Science of Sport (MS), Environmental Science (SH) and Food Science (AO'D). The modules are trialled in schools, where possible, by the authors, by other 4th year science education students and by science teachers. Each module is revised on the basis of the evaluation and then made available at low cost. So far 12 different modules have been developed, which have considerably extended the range of science materials for TYP, giving teachers more choice. TY Science has also tested a useful model for involving trainee science teachers in curriculum development, working with more experienced science teachers in the evaluation of the materials.

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USING VIDEOS AND THE CHEMSOURCE SKILL INVENTORIES FOR ASSESSMENT OF TEACHING

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Probably no aspect of teaching has commanded more attention in the past two decades than assessment. Assessment is generally divided into two types: summative--assessment **of** learning, and formative-- assessment **for** learning. For students, summative assessment, which includes unit tests, final exams, and state high-stakes testing, is useful for calculation of grades, evaluation of the effectiveness of the curriculum, and evaluation of classroom instruction. Formative assessment, or ongoing classroom assessment, is used primarily to inform and adapt instruction and is seldom used for grading purposes. It can be written or verbal, structured or informal, prior to instruction, after instruction, or during instruction. Assessment of students by the teacher, students by other students and self assessment are all part of formative assessment. These types of assessment have been routine for decades with respect to students, but seldom have they been applied to teachers or those preparing to teach, perhaps because of a lack of quantitative instruments that would be effective as well as fair and just[1].

This paper will highlight a set of 7 general and 21 science specific teaching skills inventories with detailed sets of behaviors expected to be observed for each skill, and how they can be used with accompanying videoclips for teacher peer-assessment or self-assessment[2]. The general skills include classroom management, laboratory instruction and mathematical problem solving. Among the specific teaching skills are: handling questioning, obtaining feedback, using demonstrations, using models and analogies, identifying and preventing misconceptions.

These inventories can also be used effectively for pre-service assessment of practice teachers by cooperating teachers and by administration. They are practical guidelines that allow for uniform assessment over a broad range of skills. The videos and accompanying materials[3] provide a series of information-rich "cases" for prospective teachers to analyze from multiple perspectives. Through the use of these materials, novice teachers can be taught to pick up clues and signals given off by experienced teachers to further their own development.

Handouts for this paper can be accessed at www.chemsource.info.

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FUTURE CHEMISTRY TEACHERS' MODELS AND VIEWS ON THE USE OF HISTORICAL APPROACH IN TEACHING CHEMISTRY IN LABORATORY

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Positive encounters with History and Philosophy of Science (HPS) during the pre-service training will help future teachers with implementing HPS in their work[1] And designing historical teaching material may help them to combine the knowledge acquired from the different aspects of their education[2]. As a part of the *Practical Work in Chemistry Education* coursework, five groups of 3–4 future chemistry teachers designed and executed a short lesson of 20–30 minutes, which included practical work and used historical approach.

The object of this case study was to examine (i) the teaching objectives of the developed practical works, and (ii) pre-service teachers' views on the pros and cons of using historical approach in chemistry education. The case study was executed using grounded theory content analysis on the written reports (N=5) of the five groups. The written reports were read through and the objectives of the lesson and the pros and cons of the historical approach were categorized. Reliability was improved using a peer review of the categories by a content analysis.

All groups (N=5) thought that historical approach is a valid method for teaching chemistry in high school. The historical contexts for their short lessons were: using milk to manufacture plastic, Voltaic pile, Joseph Black's experiments on limestone (N=2) and Michael Faraday's candle experiments. The objectives listed in the reports focused on learning the chemical concepts related to the lessons, e.g. *"to study chemical reactions of ionic compounds, especially carbonate ions, using historical context"*.

The most frequently mentioned reasons given in the reports for using historical approach in chemistry education were motivating the students, supporting the learning of chemical concepts and nature of science, and opportunity for interdisciplinary lessons. Some of the problems mentioned were: challenge for the students, extra work for the teachers, difficulties with understanding the ideas of past science, problems with historical practical work (need for special equipment, laboratory safety, integrating practice to the rest of the lesson), and motivating the students.

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SPECIAL LANGUAGE COMPETENCIES DIAGNOSIS AND INDIVIDUAL SUPPORT

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The new educational standards [1] in Germany outline four areas of scientific education. Beside *subject matter*, *gain of knowledge* and *estimation* the fourth area *language and communication* is contained. Regarding to Vollmer [2] and Rehbein[3] we argue that learning technical terms and their meanings supports general language acquisition and the gain of domain specific knowledge.

The speech will give an impression of a scientific work, which deals with diagnosis and individual support in the area of special language competencies. The first step of research was to develop and evaluate a tool to analyze the pupils' competencies [4]. This tool consists of different parts concerning production of words (Association-test), interconnection (linking skills and Concept mapping) and awareness of meaning of words. It has been used in several classes in secondary schools in NRW.

Based on these results in the next step options of language support in science classes were designed. In order to do this, a cooperation between scientific coworkers and teachers was implemented in the sense of a participatory action research [5]. These options of support are related to subject matters, language acquisition and to individual qualification of the pupils. Finally, it was evaluated how explicit language support effects pupils' subject knowledge and general language competencies.

Topics of the speech will be the theoretical background as well as results and experiences made during developing and proving the tools. Also some impressions of the cooperation work and examples will be given.

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CHEMICAL LANGUAGE IN CONTEXT-BASED EDUCATION

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During the last decades context-based chemistry teaching have been introduced at secondary school level in a number of countries, like Germany, the UK and the Netherlands. Context-based approaches aim at making chemistry more relevant to students and getting them interested for careers in chemistry-related professions. Research have shown that students experience context-based chemistry as more relevant, although this generally does not lead to higher enrolment in chemistry studies. Research on cognitive benefits of context-based chemistry education provided varying results (1).

Contexts may be considered as practices, e.g. from science, industry or society. Language is used in these practices to communicate about chemistry, and chemical language may differ across contexts (2). In chemistry education, there is a tendency to use chemistry concepts in a narrowly defined sense, but this puts aside the differences in chemical language and meaning of concepts that are characteristic for contexts.

We studied five modules which were designed as examples for the novel Dutch chemistry curriculum. Concept versions of these modules are tested in classrooms and subsequently revised. In these modules we investigated the nature and role of the contexts, the role of information sources, and the use of chemical language.

We found that in a number of modules contexts were not used as source for concept learning but were used for illustration or application. Our analysis resulted in a typology of contexts in context-based sciecne education. From our analysis, it seems that in the use of contexts the emphasis is laid on 'contexts for chemistry' instead of 'contexts for learning'. Sources like newspaper articles or popular science texts, which students are expected to use, used terms unknown to students ("sulphonate groups") and terms different from the ones used in instructional text ("protons" instead of H^+ ions).

The variety of chemical language in context-based education enriches chemical education and relates concepts to daily life, but bringing real chemistry in the classroom makes chemistry education more demanding both from the teachers' perspective and the students' perspective.

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LANGUAGE COMPREHENSION AND LEARNING CHEMISTRY

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While mathematical ability has long been implicated as crucial for learning Science, the role of language ability remains largely uninvestigated. The present study explores correlations between language comprehension ability and performance in general chemistry. A general theory of language comprehension known as the Structure Building Framework[1], a model that describes how linguistic information is incorporated into one's existing knowledge base, guides our work. According to the Structure Building Framework, low-skilled comprehenders are at a distinct academic disadvantage for two main reasons.[2] First, low-skilled comprehenders have poorer access to recently comprehended information—they develop too many mental substructures during comprehension, creating fragmented knowledge that is difficult to retrieve. Second, low-skilled comprehenders inefficiently suppress irrelevant information. We demonstrate here that comprehension ability correlates strongly with chemistry course performance. An examination of variables predicted to interact by the Structure Building Framework suggests that high comprehension ability may be insufficient to compensate for low prior knowledge in certain classroom contexts (e.g. a one-semester general chemistry course). Intriguingly, our results also suggest that instruments used to measure comprehension ability and math ability are not wholly independent of one another. We also report the design and analysis of a multiple-testing[3] intervention strategy consistent with the Structure Building Framework that appears to close the chemistry achievement gap between students of low and high comprehension ability. The effect of different types of questions (multiple choice versus elaborative interrogation[4]) on this multiple-quizzing strategy has also been investigated.

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THE ELEPHANT IN THE ROOM: IRISH SCIENCE TEACHERS' PERCEPTION OF THE PROBLEMS CAUSED BY THE LANGUAGE OF SCIENCE

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The language of science is a problem that students face in both second and third level education. Wellington and Osborne (2001) claimed that "language is a major barrier (if not the major barrier) to most pupils in learning science" (p. 2). Science has its own language and difficulties presented in acquiring and understanding the language act as barriers for many pupils. However, to-date in Ireland, little research has been conducted into the problems caused by language in the teaching and learning of science at second level.

This study is a part of a larger project on language in science teaching. The purpose of this paper is to examine the level of awareness of Irish science teachers of the problems which the language of science poses to their pupils. This preliminary work also identifies whether teachers have experienced any of these problems and assesses if and how they respond to the problem(s) created by the complex and multi-faceted nature of the language of science. Data was collected using questionnaires which were administered to 80 second-level science teachers within the Munster region in Ireland. These were analysed used the SPSS package (version 19) and the findings are presented in detail in this paper. These findings will be used in later stages of the project in the development and evaluation of teaching and learning strategies and materials for science at second level.

Improving the quality of second level science education is vital to producing Ireland's 'knowledge economy' and scientifically-literate citizens. The old proverb says that given a fish, one can eat for a day; taught to fish, one can eat for a lifetime. We cannot improve second-level science education without addressing the underlying problem of scientific language, as language is a major barrier for many students in understanding and enjoying science in the junior cycle. Helping students to master the language of science enables them to become fishers themselves, with a liftime thirst for knowledge and the skills to seek and learn on their own (Staver, 2007).

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SCIENCE TEACHERS` PERSPECTIVES, NEEDS AND KNOWLEDGE ABOUT DEALING WITH LINGUISTIC HETEROGENIOUS CLASSES

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Linguistic heterogeneity and the difficulties caused by it are well known problems in science classes in German schools. Linguistic heterogeneity causes deficits in students` learning efforts, their understanding, and actively participating in science classroom. However, it seems like most of the science teachers are little or no sensible for the problems caused by the linguistic heterogeneity of students. Furthermore, it seems like science teachers don't have any strategies how to deal with this problem. On the other side, for closing these gaps, there are no reliable results about German science teachers` perspectives, needs and knowledge about this issue.

Thus, the study gives more details about German science teachers` perceptions, needs, knowledge and PCK about dealing with linguistic heterogeneity in science classes. Furthermore, the study brings information about science teachers` barriers concerning dealing with the linguistic heterogeneity but also their wishes when it comes to the help while planning and accomplishing of science lessons in linguistic heterogeneous classes. Because of the importance of the scientific language for learning science the named aspects are supplemented by the issue of teaching scientific language in science classes.

The study is both quantitative and qualitative in nature. The quantitative study bases on two Likert-type questionnaires developed by Cho and McDonnough[1] and Lee et al. [2]. The qualitative study is based on open interviews about science teachers` knowledge and their PCK (Loughran et al.[3]) about the presented issue. The quantitative study gives more basic information about the perceptions, needs, barriers and the wishes of science teachers concerning linguistic heterogeneity in science classes in Germany. The qualitative study focuses on science teachers` knowledge and their PCK about teaching of scientific language.

The results of the study will be presented and the implication for German science teacher education and science teaching will be discussed.

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THE EFFECTS OF ARGUMENTATION MODEL ON STUDENTS' CONCEPTUAL UNDERSTANDING: STATES OF MATTER AND HEAT

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Argumentation has great importance as a means to enhance students' interest, motivation, and understanding in science education.[1, 2] The aim of this study is to investigate effectiveness of an argumentation model on students' understanding of states of matter, heat, and related concepts. Semi-experimental research design was used in this study. The sample was comprised of 40 eight grade students from two different classes of a primary school in Turkey. Students in both experimental and control groups were taught by the same science teacher. While the concepts related to "States of Matter and Heat" were taught by argumentation model in the experimental group, the control group were taught according to directions of the national science and technology curriculum without any other interventions. A 15-item two-tier diagnostic multiple choice test (SMHCT) and a semi-structured interview protocol were developed and employed to collect data about the participants' understanding of the subject. Reliability co-efficient for the SMHCT was calculated as 0.63. After the instruction, SMHCT was administered to both experimental and control group students as post-test. Semi-structured interviews were conducted with three students from each group to determine their understanding of the concepts related to "States of Matter and Heat" in detail and to support the results of the test in terms of students' understanding. Analyses of experimental and control group students test scores showed that there was a significant difference between experimental and control groups in favor of the experimental group in terms of students' understanding of selected concepts. Moreover, analyses of students' responses to the interview questions also demonstrated that the experimental group students gave more comprehensive and scientific explanations to the questions.

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LANGUAGE-SENSITIVE TEACHING IN CHEMISTRY

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The purpose of the study is to investigate relations between a competent use of subject-specific language and learning outcome in chemistry with regard to students with and without migration backgrounds. Language skills are key requirements to understand and to learn subject content (Norris & Philips, 2002; Yore & Treagust, 2006). However, both international and national studies indicate that students in Germany have language problems (Stanat et al., 2010) and need to be supported in their language skills (Baur & Spetmann, 2007). In addition, Lemke (1993) points out that subject-specific language is not a part of the students' everyday language and so students need to be trained explicitly how to use subject-specific language.

For this reason, an investigation with a control group design will be conducted. One group will be taught emphasizing chemistry-specific language, the other one putting the emphasis more on chemistry content. Both groups will be trained for 10 weeks in the same content area (e.g. material and their properties, physical states). Finally, they will be compared with regard to their learning increase in content knowledge, subject-specific language skills and skills in the language of instruction.

The conception of language-sensitive teaching materials, administered test instruments and the results of the pilot study will be presented at the conference.

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VARIABLE APPROACH IN ACQUISITION OF CHEMISTRY IN SECONDARY PROFESSIONAL SCHOOL

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Researches made in Latvia and abroad during recent years have shown that students of professional secondary schools have lower level of knowledge in chemistry and understanding of environmental processes than students of general secondary schools. Students are not able to connect the information gained in chemistry classes with processes in environment and everyday life. Albeit professional education should create students' additional comprehension about chemical processes that are connected with their chosen professions, the State Standard of Secondary Education in chemistry does not foresee a different approach to chemistry teaching between professional and general secondary schools. Our researches done during 2008-2010 confirm that students of professional secondary schools in Latvia insufficiently understand the essence of chemical processes that are connected with their profession. The lack of understanding can be explained by several reasons:

1) reduced amount of chemistry lessons in professional secondary schools;
2) content of chemistry subject that is insufficiently bonded with the profession that students are studying;
3) lack of appropriate teaching aids for students of professional secondary schools.

In order to rouse interest and to form comprehension about chemical processes in professional and everyday life to students of professional secondary schools, as well as to increase the future competence of emerging professionals, we have developed and approbated teaching materials in chemistry for specialties of car mechanics and electricians in professional secondary school. Both versions of teaching materials are in line with the substance of the Educational Standard of State in chemistry, however they have essential dissimilarities. Each material contains specific information about chemical processes in professional environment of every profession; tasks and laboratory works are coordinated with the specific character of the concrete profession. The developed teaching materials are structured in order to comply with the principle of complementarity. It means that teachers can easily add to the invariable theoretical part variable informative materials, tasks and laboratory works that are conforming to the specific character of a chosen profession. Learning materials are supplemented with a package of variable tasks for unassisted work that allows students to choose tasks of appropriate complexity, on their own options. As a result, interest and motivation for doing self-sufficient tasks is increased. In the final process of the approbation, we have observed at an ~ 20% increase of the level of students' knowledge about chemical processes in surroundings and in professional environment.

Keywords: content of chemistry subject, secondary professional education, variable approach, principle of complementarity.

DIRECT AND INDIRECT EFFECTS BETWEEN ATTITUDES TOWARDS CHEMISTRY AND CHEMISTRY ANXIETY: A STRUCTURAL EQUATION MODELING APPROACH

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The phenomena of chemophobia will hinder effective chemistry learning among secondary school students. Chemistry anxiety is one of the reasons which contributes to low enrollment and less motivated chemistry students and low achievement in chemistry despite the fact that chemistry is an interesting aspect of science and plays a vital role in human's daily lives. The purpose of this study was to investigate the direct and indirect effects between attitudes towards chemistry and chemistry anxiety among science students via the Structural Equation Modeling Approach. This was a non-experimental quantitative research and sample survey method was used to collect data. Samples were selected by using a cluster random sampling technique. In this study, chemistry anxiety was defined as 'Learning Chemistry Anxiety', 'Chemistry Evaluation Anxiety', and 'Fear of Chemicals'. Attitudes towards chemistry was defined as 'Liking for Chemistry Theory Lessons', 'Liking for Chemistry Lab Work', 'Evaluative Beliefs about School Chemistry', and 'Behavioural Tendencies to Learn Chemistry'. Pearson product-moment correlation, multiple regression analysis, and Structural Equation Modeling (SEM) were used to test the stated null hypotheses at a predetermined significance level, alpha = .05. The research findings bring some meaningful implications to those who are involved directly or indirectly in the planning and implementation of chemistry curriculum.

Keywords: Chemophobia, Chemistry Anxiety, Attitudes towards Chemistry; Structural Equation Modeling

STUDENTS' UNDERSTANDING OF ENERGY IN CHEMISTRY

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How students conceptualize a particular scientific concept has been extensively investigated within the paradigm of conceptual change research (Vosniadou, 2008). This research suggests that students of different age may hold differently elaborated conceptions of a particular concept (see e.g. Driver, Leach, Scott, & Wood-Robinson, 1994). Concerning the concept of energy, Watts (1983) derived different categories of students' conceptions (e.g. anthropogenic views or energy as a fluid). Liu and McKeough (2005) reanalyzed the TIMSS 1995 items and found that students seem to develop an understanding of the energy concept along the following sequence: forms and sources, transition and transformation, dissipation, conservation (see also Lee & Liu, 2010). However, most research in this area mainly focuses on physics.

To expand this view, school and university textbooks were analyzed to extract central aspects of the energy concept in chemistry. Additionally, the sequence and interrelation between different aspects within the different books was investigated. The results suggest that eight different aspects can theoretically be distinguished (sources, forms, states, constructs, transformation, qualitative balancing, quantification, and free enthalpy). All aspects are discussed in several parts of the textbooks but little connections are explicitly drawn.

Based on this content analysis, assessment items were developed for all eight energy aspects in order to investigate, whether these can be separated empirically. We hypothesized that the items would be increasingly difficult along the eight theoretical categories. The pilot study with N = 100 students in the 10th grade suggests that this hypothesis can be confirmed. Reliability of the instrument was $\alpha = .7$ which commonly is considered sufficient for instruments investigating complex constructs such as conceptual understanding. In summary our findings confirm that students progress in understanding the energy concept along the hypothesized sequence of conceptions of energy. Results of both the content analysis and the empirical test will be presented. Finally, a proposal for an ´energy curriculum´ will also be discussed.

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EFFECTS OF ONLINE CONTENT DRILL VERSUS WEB-BASED BRAIN TRAINING ON STUDENT SUCCESS IN HIGH SCHOOL CHEMISTRY

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As secondary schools prepare students for high-stakes testing and university/college readiness, Web-based programs have become commonplace. When selecting materials and/or programs, what type of supporting material to use to increase student achievement the most remains a pertinent question. This study was conducted to evaluate the effects of an online chemistry content drill software package and a Web-based brain-training program geared towards first-year high school student achievement. The commercially available programs compared included Study Island (online drills targeting content improvement) and Lumosity (brain-training programs designed to improve logic and spatial abilities). Analyzed student data collected over a twelve (12) week period from the two programs are presented. Pre-Advanced Placement (pre-AP) student progress was measured using two pre/post instruments: Group Assessment of Logical Thinking (GALT) and the California Chemistry Diagnostic Exam to assess logical thinking ability and content attainment.

EXPLORING AN APPROACH TO RAISING STUDENTS' INTRINSIC MOTIVATION IN LEARNING CHEMISTRY

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This paper introduces a research project in which five high school chemistry teachers working in cooperation with university educators, implemented a new teaching approach especially geared to promote intrinsic motivation of students towards enhancing students' scientific and technological literacy. The intention was to induce change in chemistry teachers' teaching approach through the use of especially designed motivational context-based learning modules. This was expected to involve a shift from an approach related to more traditional, extrinsically motivational teaching styles, into student centred approaches promoting students' intrinsic motivation. Pre- and post-intervention instruments were adapted from Deci and Ryan [1] to determine students' intrinsic motivation using five sub-scales. Students (N=420) completed a validated questionnaire before and after the first implementation of a context-based module. Additionally, longitudinal data was gathered in the next school year after multiple use of implemented modules. Paired samples t-test was performed to investigate motivational differences between pre- and post- questionnaire responses and one-way ANOVA with post hoc testing to explore motivational differences between the students of different schools.

Based on the outcomes, it was found that students' intrinsic motivation within all measured sub-scales was significantly higher related to the lessons based on the modules compared to their previous chemistry lessons in all schools. While significant differences existed in questionnaire responses between the schools before the intervention, there was no significant differences between the schools in post-questionnaire results. It was assumed this was a result of the suitability of the developed learning and teaching materials together with cooperative use of the modules by participating teachers. Students' intrinsic motivation in learning through modules after multiple implementation of designed modules, compared to the first implementation, did not change significantly. Recommendations will be given on enhancing intrinsic motivation in students.

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HOMEWORK MOTIVATION AND ACHIEVEMENT IN CHEMISTRY EDUCATION

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One of the most complex learning opportunities for students is homework. Students, teachers and parents are involved in the process and have different attitudes towards homework. One of the reasons to assign and to do homework is to improve achievement in a school subject. The effect of homework on the learning outcomes in chemistry as school subject has not yet been examined. This paper investigates the influence of homework assignments on homework motivation and thus achievement of 9th and 10th graders of German upper secondary school chemistry classes. The expectancy-value theory of motivation forms the theoretical basis of the homework model proposed by Trautwein et al. (2006). This model underlies the following studies. Investigating the features of tasks that might influence motivation to do homework and the effect a variation of motivational effective features might have on students' learning outcomes the following research questions are addressed:

1. To what extent could homework assignments in chemistry education positively influence students' motivation with regard to value beliefs and expectancy beliefs?
2. What effect does a variation of expectancy beliefs and value beliefs towards homework assignments have on students' achievement?

To answer the first research question, an exploration study was conducted in which homework assignments were created for eight consecutive lessons and were evaluated by students with regard to motivational aspects. The purpose of this evaluation was to select assignments to be used in the second study. To answer the second research question, a quasi-experimental study was conducted in which assignments found to differ in students' self-reported value beliefs and expectancy beliefs were given for homework over the course of eight lessons. To investigate the effect the differences in motivational aspects of the respective assignments had on achievement, achievement data were obtained in a pre-post design.

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GUIDED LABORATORY REPORTS IN PHYSICAL CHEMISTRY COURSES: AN OPTION TO PROMOTE CONNECTIONS BETWEEN THEORY AND EXPERIMENT

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Laboratory reports are essential components of chemistry learning. They foster students' familiarization with the organisation, analysis and interpretation of data and simultaneously incorporate the benefits of "writing about chemistry to learn chemistry"[1,2]. The conceptual demands of physical chemistry courses – with comparatively high complexity in the interplay of theory and experiments – suggest the opportunity of maximising these benefits through apt approaches. An approach that has been explored for more than 10 years at the University of Venda (a "historically disadvantaged" university in South Africa) attempts to utilise the laboratory reports as one of the options aimed at decreasing the impact of difficulties related to the underprivileged-context characteristics of the local situation, from the problems inherent in second language instruction and in students' general poor language mastery to the diffuse passive attitudes and the often inadequate background-preparation.

Detailed guidelines to the lab report have been designed to ensure that students do not neglect important aspects of the experiment analysis and relate their observations and interpretations to the concepts introduced in lecture sessions. Thus, the guidelines for the theoretical background section stimulate the revision of all the concepts relevant for a better understanding of the given experiment. The guidelines for the observations section guide students to efficient data organisation and call for accurate descriptions of any change observed. Those for the treatment-of-results section provide step-by-step guidance through the analysis and interpretation of observations and data. A major challenge in the design of guidelines of this type is the search for approaches that can maximise the benefits of guidance (direly needed in an underprivileged context) while simultaneously allowing adequate space for student's initiative and avoiding spoon-feeding.

The presentation outlines: the main features of the approach; the current stage of the search for a functional balance between guidance and students' initiative and for ways to maximise the benefits of writing; the students' responses; and a first-approximation evaluation of the approach effectiveness. All these aspects are illustrated by the consideration of concrete examples.

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STUDENTS CREATIVITI IN CHEMISTRY CLASSES

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The chemistry teaching has the potential to encourage students to think flexibly in order to increase a variety of approaches to solving problems and, in that way, to contributes to development of learners creative capacities. The assumption that chemistry can stimulate creativity depends on the way chemistry is taught. The aim of this study was to investigate the contribution of different methods of the *Stoichiometry* elaboration to development of divergent thinking and creativity of primary school students (aged 13).

The effects of the elaboration of the Stoichiometry by different methods of teaching were tested in a pedagogic experiment with parallel groups. The research was carried out within six sessions during the 2010/2011 academic year. Two seventh grade classes (50 students) from Mathematical Grammar School in Belgrade were chosen as a sample. The Mathematical Grammar School is a unique school in Serbia, specialised for students talented in mathematics, physics and computer science, aged 13-18 (the School includes the two final grades of primary school, age 13-14). At the beginning the students were asked to do a pre-test. One group (group A) was taught by a combination of the demonstration methods and the stoichiometry calculations. The other class students (group B) were divided into several groups. Each group had few tasks: (i) to conduct experiments and according to results to create stoichiometry problems and (ii) to read the text and according to the information from text to develop stoichiometry problems. At the end of the experiment, a post-testing was organized in order to examine the contribution of different methods of teaching to the development of divergent thinking in both groups.

At the pre-test, the group A showed a slightly higher overall result than the group B, but the difference is not statistically significant. However, the results of post-test showed the great number of different types of responses was given in group B. According to that we can say that applied teaching methods have the potential to contribute to development of divergent thinking of students.

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THE DEVELOPMENT OF PRESERVICE CHEMISTRY TEACHERS' PEDAGOGICAL CONTENT KNOWLEDGE REPRESENTATIONS ABOUT THE NATURE AND BEHAVIOR OF GASES

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Research in science education commonly explored experienced teachers' pedagogical content knowledge (PCK), but very few studies examined the nature or development of preservice teachers' PCK [1]. This study focused on identifying and describing the development in the extent and features of preservice chemistry teachers' PCK representations when they collaborated with their peers in the context of a semester-long chemistry teaching methods course. A multiple case study approach was utilized to capture the complex and multifaceted elements of PCK. Three female preservice chemistry teachers' PCK about the nature and behavior of gases was examined using the tool of Resource Folio and interviews at the beginning and the end of semester. Resource Folio, which includes the dimensions of Content Representations (CoRes) and Pedagogical and Professional-experience Repertoires (PaP-eRs), is a tool for accessing science teachers' understanding of the content and the relevant pedagogy [2]. Qualitative data were analyzed by employing both qualitative and quantitative methods.

Five common components of PCK were identified in the data, and their labels came from the PCK components as identified in the past literature, that is: *Knowledge of goals; Knowledge of curriculum*; *Knowledge of student thinking*; *Knowledge of teaching,* and *Knowledge of assessment* [3]. The three participants exhibited remarkable progress concerning science teaching *goals*, *student thinking* and *teaching* chemistry in terms of both in quantity and quality from the first to the second PCK representation. Meanwhile the participants indicated the least progress on the components of *curriculum* and *assessment*. Such pattern seems to be aligned with their coursework. Student conceptions, goals of science instruction, and the various methods of teaching were addressed quite extensively in the chemistry teaching methods courses. However, the participants barely explored the chemistry curriculum in any of their science specific pedagogy courses. In addition, they learned about assessment in a limited extent in different courses. This suggests that the preservice teachers' PCK are not developing uniformly across the all five components, and the extent of progression in the component of PCK closely related to the content of the courses they took in science teacher education program.

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SUPPORTING NEW ZEALAND CHEMISTRY TEACHER PROFESSIONAL DEVELOPMENT THROUGH CORES AND PAP-ERS ON A WIKI

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Content Representations (CoRes) and Pedagogical and Professional-experience Repertoires (PaP-eRs) have been used as research tools and as professional development mediums to support pre- and in-service teachers in making their (static and dynamic) knowledge of practice explicit[1,2], in particular their Pedagogical Content Knowledge (PCK), i.e., 'that special amalgam of content and pedagogy that is uniquely the province of teachers'[3]. However, the construction of CoRes have been critiqued as cost and labour intensive[4], as organising groups of teachers to construct them is a difficult task due to daily classroom life taking over. This project is looking at resolving the issues of sustained CoRe and PaP-eRs design by facilitating the process through online teacher knowledge-building networks[5] using a wiki. A wiki is a collection of interlinked webpages that allows users to access and edit the content of these pages, thus affording the creation of a community-based repository of knowledge. The online nature of the wiki provides opportunities for synchronous and asynchronous discussion in which teachers can engage in a time that is most suitable for them. However, apportioning responsibilities on a wiki requires important consideration to ensure sufficient engagement[6]. This project is exploring pre- and in-service teachers' perceptions of online environments as collaborative tools, their willingness to engage in such environments in a continuous and sustainable manner, and the development of professional practice in completing CoRes and PaP-eRs. The findings will potentially have important implications for how pre- and in-service teachers can be more effectively supported to articulate, critique and reflect on their practice in a collaborative manner.

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HOW CAN WE EXPLAIN AND PREDICT THE CHEMICAL BEHAVIOUR OF SUBSTANCES? STUDENT TEACHERS' CONTENT KNOWLEDGE AND PEDAGOGICAL CONTENT KNOWLEDGE REGARDING THE BASIC CONCEPT OF STRUCTURE-PROPERTY-RELATIONS

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Knowledge in school is often structured in different ways than knowledge at university; in Germany, school curricula describe so-called basic concepts (e.g. matter and particles, chemical reactions) whereas university study courses still follow the traditional structure of inorganic chemistry, organic chemistry and so on.

Student teachers therefore have to connect their own learning to both categorization schemes, partly supported by their chemistry education courses. While there are several studies on students' (mis- or pre-)conceptions in the literature[1-5], there are no test results yet showing how well student teachers understand the basic concepts themselves and what they already know at the time of their university education about the teaching and learning of such concepts.

This paper presents a study investigating student teachers' content knowledge (ck) and pedagogical content knowledge (pck) on the exemplary basic concept of structure-property-relations. The items for the test instrument had been designed using the following model and design principles: for the ck test, items regarding both *properties* and the *reaction behaviour* were generated, whereas for the pck test, items for the dimensions of *student cognition* and *instructional strategies (including experiments and models)* were developed. For both ck and pck, the items were also classified according to their difficulty based on the Model of Hierarchical Complexity for Chemistry[6].

The test instrument will be used within a larger project assessing student teachers' competencies necessary for teaching science subjects (called KiL) at ten German universities. First results, both qualitative and quantitative will be presented in this talk.

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A MULTI-METHOD INVESTIGATION OF STUDENT TEACHERS' CONTENT KNOWLEDGE AND PEDAGOGICAL CONTENT KNOWLEDGE OF CHEMICAL REPRESENTATIONS

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Chemical representations, especially chemical formulae and equations, describe chemical contents in a well-defined and brief way. Therefore chemists consider chemical representations as a major tool for communicating about chemical contents. Chemical representations do not only have a high relevance for working as a chemist, they are also necessary for learning and teaching chemistry at school and university. Learning this specific language is therefore an important goal for chemistry education. However, this goal sometimes seems hard to reach: Numerous national and international studies have shown that students have remarkable difficulties in understanding and using chemical formulae and equations.[1,2] Other studies have shown that even chemistry students at university struggle with similar problems regarding symbolic representations.[3]

In the research field of chemical representations, student teachers are a quite interesting group to focus on: On the one hand they have to learn about chemical representations themselves just as chemists do. On the other hand they have to develop special abilities during their university education in order to teach chemical representations to their prospective students at school. The study presented in this paper therefore investigates both the student teachers' content knowledge (ck) and pedagogical content knowledge (pck) in regard to chemical representations by a multi-method design. Based on a literature review of students' difficulties regarding chemical representations, test items have been developed and piloted in order to analyse student teachers' ck and pck at ten German universities within a larger project assessing student teachers' competencies necessary for teaching science subjects. The ck items investigate student teachers' abilities to interpret, construct and translate chemical representations (e.g. formulae, equations, ball-stick-models). Additionally, eye-tracking techniques in combination with think-aloud interviews are currently carried out to analyse how these student teachers' abilities differ from those of chemists. The pck test items investigate student teachers' awareness of students' difficulties regarding chemical representations reported in literature as well as their knowledge about instructional strategies for teaching chemical representations at school. First results will be presented.

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COMPARING SECONDARY SCHOOL TEACHERS' PROFESSIONAL KNOWLEDGE IN CHEMISTRY AND PHYSICS AND THEIR STUDENTS' OUTCOME

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Teachers' professional knowledge is seen as one of the most important preconditions for students' learning success[1]. According to Shulman[2] teachers' professional knowledge can be divided into several dimensions, of which content knowledge (CK) and pedagogical content knowledge (PCK) are to be focused on in this project. While it can be assumed that chemistry and physics instruction differ from each other[3], there is little information concerning the subject specificity of teachers' CK and PCK, especially within the same topic.

Thus, investigating CK and PCK of chemistry and physics teachers at secondary school level is one important aspect of this study. Because teachers' CK and PCK are presumed to determine students' learning, students' outcome and attitudes are also examined. To these ends, large-scale test instruments and questionnaires, that refer to the topic "water and state of matter"[4,5], have been used. The reason for choosing this topic was its inclusion both in the 6th grade physics curriculum and 7th grade chemistry curriculum. A total of 14 chemistry and 25 physics teachers working at upper level secondary school and 617 7th grade chemistry students were asked to fill out paper pencil tests and questionnaires. 254 of these students took part in the 6th grade physics course one year before[4,5] and allow a direct comparison of data.

While the study revealed no significant differences between chemistry and physics teachers' CK and PCK, physics teachers consider motivation to be more important for learning than chemistry teachers ($t(36) = 2.985$; $p = .005$; $d = 0.96$). Furthermore, there is no significant difference in students' learning success between grade 6 and grade 7. However, students' previous knowledge in grade 7 has a deeper impact on final learning outcomes ($t(253) = 9.347$; $p < .001$; $\beta = .545$) than their knowledge at the end of grade 6 ($t(253) = 2.178$; $p = .030$; $\beta = .133$). A short repetition of the 6th grade physics topic one year later in chemistry seems to be useful.

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DIFFERENTIAL ITEM FUNCTIONING ON MULTIPLE CHOICE GENERAL CHEMISTRY ASSESSMENTS

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The use of testing to determine student grades imparts an imperative that tests be fair and objective. When subgroups of equal proficiency perform differently on an assessment item (where equivalent proficiency students should have equivalent probability of answering an item correctly) this is called differential item functioning (DIF). Based on the test development process that includes trial testing, general chemistry items that exhibited possible DIF were identified. These general chemistry items were then studied for persistence and the extent of persistence with the use of internally and externally relevant measures of proficiency matching as well as stakes of testing. To examine for underlying causes of DIF items, these items were further cloned based on either format or content. These cloned items were then examined for amplification or cancelation of DIF. The results of this study will be presented along with potential implications for test item writing and the role of testing within curricular reform.

BENCHMARKING FIRST-YEAR CHEMISTRY AT AUSTRALIAN UNIVERSITIES

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A typical first year chemistry cohort in Australia is characterized by large classes of students, with a range of academic abilities, interests, and motivations for learning. These students are enrolled in many different programs of study that require some chemistry, and failing their chemistry subject will usually delay their progression. Summative assessment forms a crucial part of the student experience and defines success and failure. However, given the massive importance of summative examinations, it is surprising that little or no oversight is given to the preparation of such examinations. Most importantly, the standard of difficulty and the content covered by the examination depend entirely on the person writing it. Thus, there is no way to compare the performance of two students at different institutions, or even at the same institution in different years, as the examination instrument may change. At the vast majority of Australian universities there is no internal or external moderation of examination papers. Both the United States and the United Kingdom, through their Chemical Societies (the American Chemical Society[1] and the Royal Society of Chemistry, respectively), have long used standardised exams. Independently developed and normalised assessment allows objective determinations of the level of subjects and provide evidence of appropriateness of subject expectations of students.

This project is evaluating the potential of employing standardised exams as a benchmarking tool for Australian university chemistry classes, initially using tests developed by the American Chemical Society Exams Institute.[1] The benchmarking in this project is of student **outcomes**; this is different from much tertiary benchmarking, where methods and processes are compared. The project is also working towards the development of a suite of examination questions for the Australian context. This process is coupled to and compared with the sharing of teaching activities, strategies, examples of current teaching practices, and examples of assessment items currently employed.

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THE CONCEPTUAL DEVELOPMENT OF 7TH–9TH GRADE STUDENTS IN CHEMISTRY

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Relevant competences in science education are, as to date, mostly identified on the basis of competence models. These are frameworks for organizing available competences (descriptive) or for targeting competences (normative). However, there is no empirical evidence in which way conceptual understanding evolves (Schecker & Parchmann, 2006). This study aims to remedy this shortcoming by developing and validating test items that are able to capture the development of students' achievements longitudinally in selected content areas. The development of valid test items bases on a three-dimensional competence model (Figure 1).

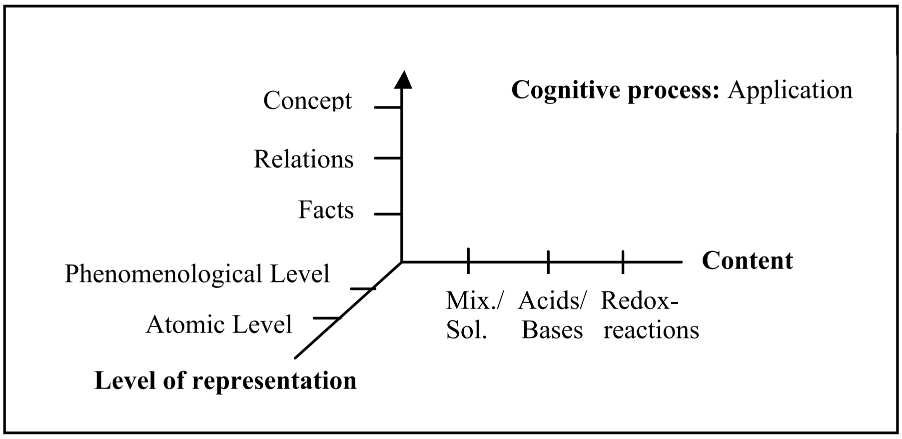

Figure 1. The competence model

On the basis of this suggested competence model 221 test items were developed to be used in a multiple choice single select instrument. The test instrument is administered in a multi-matrix design to students from nine schools in North Rhine-Westphalia. Each school provides at least one course of the academic years 7, 8, and 9. To enable an empirically based description of the development of conceptual understanding, each course is surveyed three times in one year in a longitudinal study. The first point of measurement was in September 2011. The second point of measurement follows in March 2012, and data collection will close in September 2012. Overall, 1080 students from grades 7–9 participate in this project. Results from the first point of measurement come from Rasch-analyses: Estimated person measures range from -.89 for grade 7, over -.62 for grade 8-students, to -.28 for grade 9-students. In due consideration of the averages it can be mentioned that the effect of the grade is highly significant ($F(2,1077) = .96$; $p < 0.001$; $eta^2 = .15$). This indicates an increase of scientific knowledge as measured by the instrument over the course of chemistry lessons in the three academic years. Further analyses are in progress and will be available by the time of ECRICE 2012.

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FACILITATING LONGITUDINAL CURRICULAR AND PROGRAM ASSESSMENT

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A key challenge associated with curricular reform lies in establishing the efficacy of the changes made. As such, systematic assessment efforts are commonly expected for such projects. Additionally, within a discipline like chemistry with its fundamentally sequential organization of content learning, the impact of change at one stage of the curriculum can be important for subsequent courses. Because the American Chemical Society has supported nationally-normed tests for decades via the Examinations Institute, these issues can be addressed by measuring students learning with nationally referenced exams. Recently, to further enhance this resource, the Exams Institute has developed a map of the content organized by anchoring concepts, or "big ideas". Working with educators from the various sub-disciplines in chemistry, 10 anchoring concepts have been identified. These ideas are then articulated with broad statements (called enduring understandings) that span all of college chemistry, and then further articulated utilizing sub-disciplinary specific concepts. The manner in which such a content map can be used to follow student learning about topics such as chemical bonding or reaction kinetics, as they

ALTERNATIVE ASSESSMENT STRATEGIES IN A GENERAL EDUCATION CHEMISTRY COURSE

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The traditional assessment of student knowledge in higher education chemistry emphasizes mimicry strategies, where the student is challenged to perform activities commensurate with what an expert might do in the same setting. This includes questions at a variety of cognitive levels. Alternative assessments, in contrast, emphasize allowing the student to present his or her knowledge in a form that reflects their own personal understandings. To do so often means allowing students some choice about the setting of their knowledge, even to the point of letting them choose the topical foci for the assessment. A course in the chemical sciences for general education students has provided us with an opportunity to test several forms of alternative assessment, including thematic projects, journals, and expressive writing in the laboratory. Examples of these assessments, including findings about the nature and effectiveness of some different choices within the assessments, will be shared.

BESOCRATIC

Melanie Cooper, Mike Klymkowsky, Sam Bryfczynski

BeSocratic, is a web-based formative assessment system that can recognize and respond to free-form student input in the form of representations including graphs, simple diagrams and chemical structures. It consists of three components: an interface on which students can draw, input text and some gestures (on an iPad or touchscreen computer), an authoring tool for development of a range of different activities, and an analysis tool that allows researchers to mine the data that are collected as students work through the activities. This presentation will show examples of each component, and how they have been used in conjunction with curriculum reform efforts to improve student understanding of core concepts, the development of representational competence, and the ability to answer questions scientifically.

LEARNING THROUGH PROBLEM SOLVING

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According to Resnick (1987) "school should focus its efforts on preparing people to be good *adaptive learners*, so that they can perform effectively when situations are unpredictable and task demands change."[1] One important goal of education is to train students to solve problems using reasoning; in this way it will be easier for them to adapt the acquired schemas in other situations. The majority of students enrolled in my general chemistry course find it difficult to solve problems in a meaningful way. A questionnaire distributed to about 400 freshman engineering students showed only about 30% of them selected the correct equation to express the following statement: "There are six times as many students as professors at this university."[2] About the same fraction solved correctly the stoichiometric problem: "10.00 g of Na_2CO_3 reacts with 10.00 g of HCl. If one of the reagents is completely consumed, calculate the grams obtained of each product, explain your reasoning, and outline a method to verify your results."[3] This can be an indication that we need more intriguing methods to teach chemistry and a more engaging way to teach problem solving.

Expert problem solving consist of the formation of seven meaningful stages[4]: because students love them, the use of some logic problems can help in developing problem solving strategies and a better attitude toward solving problems. In a general chemistry course, the initial problems tackled were non-chemical and non-algorithmic[5] to emphasise the analysis, representation, and synthesis operations without the interference of chemical concepts which students may not have mastered as yet.

Students need to be successful in solving problems: successful experience brings confidence and confidence is a very important factor. For any problem, the student first must be willing to make an attempt to solve it. Many students that successfully solve logic problems are also the best at solving stoichiometric problems.

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USING CELL PHONES AND PEER INSTRUCTION TO ENHANCE UNDERSTANDING AND LEARNING IN LARGE FIRST-YEAR CHEMISTRY CLASSES

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This study made use of cell phones as electronic student response systems (also known as clickers) in addition with peer instruction (PI) in order to enhance student involvement in a large first year chemistry class and to improve the understanding of conceptually difficult topics.
Clickers are typically hand-held remote control devices which allow large groups of students to immediately submit their answers to multiple choice questions (MCQs) which are then automatically recorded by an electronic receiving unit and the results are made available immediately[1,2]. These results can provide feedback on the students' individual responses as well as the response of the class as a whole. Peer instruction is a multi-step process that promotes classroom interaction whereby students are engaged to discuss topics and help each other[3].
The subjects for this project were students in a large introductory course to General Chemistry at Stellenbosch University. The course instructor used cell phones as electronic response systems to poll students frequently (at least one test of approximately 5 minutes per lecture) for answers to short, in-class, MCQs. The tests were unannounced and were aimed to test a) recall or procedural knowledge and b) conceptual understanding of a specific challenging topic. Students were provided with a first test opportunity and had the opportunity to discuss their answers with their peers after submission of their answers. A second generic type of test was then made available to the students. Quantitative data for this project include correlation of test scores before and after PI. Qualitative data were collected by means of student questionnaires.
The results from this research reveals firstly whether cell phones used as student response systems together with the use of PI can lead to improved learning and better conceptual understanding in chemistry and secondly whether cell phones is a meaningful alternative for traditional clickers as student response systems in the South African context. This research furthermore shows the use of cell phones as clickers used together with PI to enhance student interaction and engagement in large classes.

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TEACHING STATE OF MATTER AND HEAT WITH JIGSAW AND STAD MEDHODS CLASSROOMS IN LOWER SECONDARY SCHOOL CHEMISTRY LESSONS

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Student-centered methods have repeatedly been shown to be superior to the traditional teacher-centered approach to instruction, a conclusion that applies whether the assessed outcome is short-term mastery, long-term retention, or depth of understanding of course material, acquisition of critical thinking or creative problem-solving skills, formation of positive attitudes toward the subject being taught, or level of confidence in knowledge or skills. This study describes and discusses an example of how state of matter and heat can be taught in lower secondary chemistry using a modified Jigsaw and Students- Team- Achievement-Division (STAD) cooperative learning classroom methods. The lesson was taught in grades 8 (age range 11–15 years) chemistry in three learning groups with a total of 96 students in various grammar, middle, and comprehensive schools in Turkey. This study was carried out in three different classes at the lower secondary school chemistry lessons during the fall semester of 2011-12 academic year. One of the classes was selected as the Jigsaw Group (JG) (n= 30), in which the jigsaw cooperative learning method was applied, the second was selected as the Students- Team- Achievement- Division Group (SDATG) (n=30), in which the Students- Team- Achievement- Division cooperative learning method was applied and the third was selected as the Control Group (CG) (n=36), in which the teacher-centered teaching methods was applied. Students participating in the SDATG were divided into seven sub-groups. Each of these sub-groups contained five students the results indicate that it is appropriate to demand that student-oriented and cooperative-learning methods be used more often in lower secondary school chemistry topics education.

CONSTRUCTION OF THE ACTIVITY CURRICULUM COURSE "I AND CHEMISTRY" FOR THE STUDENTS FROM THE MIDDLE SCHOOL AND HIGH SCHOOL IN GUANGZHOU

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Guangzhou is the largest city in the South of China with population of 12 million. There are 125 high schools and 300 middle schools with 540,000 students. For about 210,000 students study the Chemistry Course. In order to let the students to resolve the real questions by means of the chemistry acknowledge they had learned, since 2000, the Chemistry Department, Institute of Guangzhou Education Bureau (IGED) established a local electives which is called Activity Curriculum Course "I and Chemistry"(IAC). The students were recombined as small investigation teams with 3-5 students. Each team investigated a topic related with chemistry and submits a report as well as a paper in the end. In the past 12 years, 1,400,000 student-times and 1,500 chemistry teachers participated in the IAC. The investigations involved many aspects such as environmental protection, food security, daily life, etc. The students obtained the experiences on the value of chemistry improving the social development, the importance of harmonious development between human being and environment, and the basic approaches of chemistry research. The students' interest on chemistry study improved significantly. Some of the reports caused the high attention of the relevant government departments or corporations to improve their work. Up to now, 3 volumes of *Collected Papers of "I and Chemistry"*(CPOIAC) have been published. The CPOIAC includes 136 investigations with 600,000 words in total. In this paper, we introduce the construction of IAC including the character, objectives, contents, methods, evaluation and management, etc.

Key Words: I and Chemistry (IAC), Activity Curriculum Course, Inquiry learning

METHODOLOGY OF TEACHING/LEARNING CHEMISTRY FOR GIFTED STUDENTS IN PETNICA SCIENCE CENTER - SERBIA

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Petnica Science Center (PSC) was founded in Petnica near Valjevo (Serbia, Yugoslavia) in 1982 by a group of young teachers, scientists and university students[1,2] . It is a unique non-governmental, non-profit and independent educational institution working with young people who demonstrate an inclination and interest in science beyond regular school curricula. Most of PSC's educational activities are designed for upper secondary school students (age 15-19), but there are various of programs for younger students and college undergraduates as well as for teacher training. PSC is consisted of several departments with equipment suitable for the research and teaching/learning in various sciences including chemistry. Contrary to traditional and rigid system, which was dominating in the schools, new styles and teaching/learning methods were introduced in Petnica Science Center. The emphasis is on experimental work; problem solving and students research projects. The equipment and instruments in laboratories of PSC are considerably better than those in the schools (often similar like in the university laboratories for undergraduate students). Beside permanently employed staff from PSC, many researches and scientists from various institutions (faculties, research institutes, medical institutions, and industrial companies) were also engaged for lectures and courses or as mentors of student projects. Furthermore, many young assistants (former Petnica alumni and usually university students) helps their younger colleagues. In spite of their interest for chemistry, many secondary school students did not have enough knowledge and practical experience to define and perform their projects. Therefore, the annual cycle of seminars was designed in order to provide students with theoretical and practical knowledge necessary for their research projects. Methodology for preparation of students and realisation of projects was continuously improved, from large team projects to individual student projects of high quality. The best projects were also presented at the annual conferences of young researchers. More information on PSC in English or Serbian are available at the web site www.petnica.rs or in the yearbook [3] . Students from Yugoslavia also participated several times at other international events such as International Competition "Young Europeans' Environmental Research". Some of their papers were published [4] .

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INTERPLAY OF LANGUAGE AND VISUALIZATION IN CHEMISTRY TEACHING

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Teaching and learning are communication-depending processes and, therefore, their effectiveness largely depends on the modes and quality in which communication tools are utilised and understood. Language is the first and most essential communication tool, as we do not only express our thoughts through words and sentences, but also develop them (in our minds) through words and sentences. Visualization plays important roles because of its immediateness and because of the importance of the generation of mental images for science learning[1]. In chemistry, it has a fundamental role to familiarize students with the microscopic world of atoms and molecules. The search for optimal balance between communication through language and communication through visualisation in the classroom aims at maximizing the benefits of both. Diagnosed learners' difficulties, in more than one context, highlight the interdependence of the mastery of the two tools for chemistry learning2,3 and the importance of actively fostering the development of learners' literacy for each tool, and for their interfaces, starting from the pre-university level, which sets the bases for the way in which learners will master and utilize these communication tools within a science discourse.

Specifically for visualization, the major educational challenges can be expressed through the following questions:

i) how to design images that communicate rigorous scientific information despite the simplification often inherent in visualization?

ii) how to ensure that learners get the desired messages from images?

iii) how to actively involve learners in the design of images, so that the visualization communication-tool is used not only in one direction (from the teacher to the learner), but in both directions, thus enhancing learners' mastery through hands-on approaches and, simultaneously, offering teachers precious information about learners' perceptions? The search for answers to these questions points to the essential role of interfaces and interplays between communication through language and communication through imagery in the class, so that the two communication-tools enhance each other effectiveness.

The presentation considers and analyses a number of concrete examples, and serves as introduction to a workshop on the same theme.

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REFLECTING AUTHENTIC LEARNING ENVIRONMENTS IN PRE-SERVICE CHEMISTRY TEACHER EDUCATION AND TRANSLATING IT INTO PRACTICE

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Authenticity has recently become a popular term in science education, without a common understanding of what it really means. One of the implications is "making science learning better resemble science practice" [1]. In chemistry teaching this refers to chemical research and the people involved. The pupils should not only be confronted with parts of the investigation and become 'researchers' themselves, but they should also acquire knowledge about chemistry and science, which is not necessarily achieved by solely conducting experiments [2]. Authentic learning environments are often rooted in the concept of situated learning [3] and offer one possibility to promote scientific literacy [4]. In order to realize authentic chemistry lessons, prospective teachers not only need to reflect on their conceptions of chemistry and chemical research, but also need some guidance for translating these conceptions into practice. The study focuses on these two aspects. The short term aim is to get access to chemistry teacher students' pre-conceptions; therefore a course with a two-step approach was designed. In the first step course elements aimed at initiating reflection on students' views. In a second step the pre-service teachers had the opportunity to transform their (changed) conceptions into practical activities for pupils. For the study a pre-post test design was applied: open-ended questionnaires before the course, portfolios written by the students during the course and concluding semi-structured interviews. The data was analyzed according to the qualitative content analysis by Mayring [5]. The results show that both steps were successful: All participants reflected their prior held images of chemistry and chemical research and expressed more elaborated views at the end of the course. Moreover they were able to create an out-of-school lab day for a high school class into which characteristics of chemical research were embedded, but it was also evident that they need more support. In the long run the practical activities are going to be used to identify school practical relevant elements of chemical research in order to embed them into teacher education to help students design authentic learning environments.

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RESEARCH ON PRE-SERVICE CHEMISTRY TEACHERS: PCK DEVELOPMENT AND INFLUENCES

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The purpose of this 2-year tracking study was to diagnose the PCK of chemistry pre-service teachers at different training stages in BNU, including courses stage (the first year) and teaching practice stage (the second year). At the same time, the study also explored the influences effecting on their development of PCK in different stages.

This research, based on normal students, was carried out from 2010 to 2011. Both of 2007 and 2008 undergraduate normal students in BNU were involved in this study. In every training stage, pre- and post surveys and interviews were conducted, looking at teaching orientation (about propose of curriculum, teaching contents, teaching methods and assessment of students' learning), knowledge about teaching (including subject knowledge, teaching strategies and assessment strategies) and the causes of "your development" (only in the post survey). This study found that, depending on their training stage, pre-service teachers held different levels of PCK. After the courses stage, pre-service teachers PCK had improved both in teaching orientation and knowledge. Especially, a statistically significant raise existed in orientation about teaching methods and teaching contents. We also found that the development in courses stage was mainly due to teacher's explanation in chemistry pedagogy curriculum. Simulation teaching, visiting classes and self-reflection were beneficial for improving the PCK as well. Then, after the teaching practice stage, although there was a greatly improve in knowledge about teaching, the development of teaching orientation was not significant. The score of orientation about the purpose of curriculum even slightly decreased. The result also showed that the orientation of practice school and guiding teachers about the purpose of curriculum are the main reasons. However, in the practice schools, the experiences such as interactions of teachers and students, lesson preparation and exercise-checking also helped to improve the per-service teachers' PCK.

Key words: PCK, Pre-service teacher, Chemistry, development stage

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THE CHEMISTRY MISCONCEPTIONS OF PRE-SERVICE SCIENCE TEACHERS IN IRELAND

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The Irish Education system is producing students with average reading and scientific literacy and below average mathematical skills[1]. The quality of teachers is one of the main factors affecting the quality of educational systems[2]. It also significantly affects the academic performance of pupils[3]. McKinsey consultants have graded Ireland's educational system as 'good' and identified raising the calibre of pre-service teachers as a successful strategy for improving 'good' systems[4]. The production, therefore, of teachers with a good understanding of fundamental chemistry concepts is required to ensure the education system is serving the needs of its learners.

The presence of chemistry misconceptions in pupils across all levels of education[5,6,7] has been reported internationally. Recent studies in Ireland[6,8] found that chemistry misconceptions are widespread among pupils in second-level education. In order to address this problem, teachers must be prepared to turn the findings of research on chemistry misconceptions into practice.

A pilot study was carried out with 212 pre-service science teachers in a university in Ireland[9]. The results of this semi-longitudinal study indicated that misconceptions in chemistry are numerous and widespread among pre-service science teachers and are unaltered by the number of years of science and science pedagogy study. Based on these findings, teacher training institutions across Ireland were invited to participate in a national study, one purpose of which is to compare the consecutive and concurrent models of teacher education.

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INVESTIGATING PRESERVICE CHEMISTRY TEACHERS' REFLECTIVE THINKING ABOUT INSTRUCTIONAL METHODS USING ACTIVITY-BASED INSTRUCTION IN SCIENCE METHODS COURSE

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Many studies in science education have used the reflection as a tool for understanding professional development of inservice and preservice science teachers.[1,2,3] The reflective process involves inservice and preservice science teachers looking back at earlier experiences and engaging in a reflective interchange about situations that arise during teacher training.[4] The purpose of this study was to investigate the reflections of preservice chemistry teachers about instruction methods for teaching science and especially chemistry in an activity-based science methods course. Throughout the course, the instruction methods such as individual-competitive-cooperative learning, inquiry, argumentation, argumentation-driven inquiry, concept mapping, problem-based learning and project-based learning were used for designing activities by the researchers. Preservice chemistry teachers were asked to participate in activities like a high school student and then they were asked to discuss and reflect about the instruction methods which were used in the activities for example; what is the role of the teacher and learners in this method? What are the strengths and weaknesses of this method and suggestions for improvements? Do you think that you will use this method in the future in your classroom?. The science method course was conducted in two semesters and 31 preservice chemistry teachers participated. Data sources for gaining reflections of preservice chemistry teachers included interviews, written reflections, video records of lessons and researchers' journals. The analysis of the reflections indicated that activity-based instruction enabled preservice chemistry teachers to think reflectively about instruction methods and examine the effectiveness of the developed activities and thus contributed the development of their pedagogic content knowledge for teaching chemistry.

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ORIGINAL MATERIAL FOR HANDLING GASES AT SCHOOL

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One of the most disturbing situations in the class room is the difficulty of connecting rubber or glass tubes having different diameters. In Switzerland this problem has been solved by using medical syringes and needles.

The inox needles are first cut into two parts The obtained half needle is saved. Two half needles are to be adapted at both ends of thin plastic tubes, which are then ready for use .

On the other hand, plastic syringes of different volumes are cut into two parts near the end, saving only the lower part. These half syringes may then be inserted into rubber stoppers or broader rubber tubes, whatever their dimensions. They are ready to be connected to other parts of the setup, as the cone will fit on any connecting plastic tube equipped with half needles.

This technique will be demonstrated with some real experimentsas carried out in class, like the production and use of SO_2 by burning sulphur in air, production of Hydrogen gas, oxidation of NH_3 with air on platinum, production and combustion of white phosphorous, etc.

"CHEMLIG" – INTRODUCING CHEMICAL BOND TO A SECOND LEVEL STUDENTS

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For decades card games have been developed and used to explain and reinforce different topics in chemistry classroom[1-3]. The present work proposes the use of an educational card game, called CHEMLIG, to introduce the chemical bond subject to a 2nd level students. This game was designed to verify if some issues that have been already taught, such as electron configuration, periodic properties and stability, were properly understood. The CHEMLIG uses a deck of 100 cards and may be played by 4 to 10 students at the same time. Basically, the deck has two types of cards – the first one with elements of *s* and *p*-blocks and ions, and the second one with the called "*action cards*", all of them distinguished by the background color. This second type is very important to introduce the concept of chemical bond. An example of an alkaline card and its chemical information is shown in ***Fig.1***. The central idea of the game involves transference and sharing of valence electrons, based on the *Octet Rule*. In the present work the game was applied to six chemistry classes in two public schools at Duque de Caxias district, RJ/Brazil. The students were divided in two groups, namely the "Control" and the "Testing" groups. For the "Control" set the concepts were taught without using the CHEMLIG game. On the other hand, the game has been used by the students placed in the "Testing" set. The main objective of this project is to check how the students have assimilated the chemistry concepts on both groups, the "Control and Testing" groups, and to verify if the educational game may contribute to the learning. In this way, both sets have answered an evaluation of contents about periodic table and chemical bond. The students from the "Testing" group have also answered a questionnaire to evaluate the game. The educational game CHEMLIG was considered enjoyable by the students and the preliminary results suggest that this kind of game may contribute to the learning or to reinforce chemical concepts for a second level students.

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GREEN LIGHTS THAT ENGAGE CHEMISTRY STUDENTS

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Prior knowledge, engagement, and attending to the task at hand are the required components of learning. Chemical demonstrations within the classroom can make a difference as to whether students pay attention, learn and retain the material, and sustain interest in the topic or not. As educators in trying economic times, the cost of demonstrations can be prohibitive. However, with a little creativity and planning costs can be overcome. Our chemical demonstration program highlights concepts covered in beginning chemistry and illustrates different low cost alternatives to engage your students in deeper learning.

TEACHING CHEMISTRY TO A STUDENTS WITH DISABILITIES – USING THE FIVE SENSES

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Students with disabilities need special attention in their education. Special education teachers work with students who have mild to severe learn disabilities or physical challenges. The 1988 Brazilian Federal Constitution says that the State should provide and guarantee special education to all Brazilian person with disability, in the standard schools preferentially. Despite this recommendation, students with disabilities used to be carried out on a small number of special schools in the past, but at the present they attend classes in public schools, where they are placed in regular classrooms. Unfortunately, most of Brazilian teachers have no specific training to deal with special education and no specific information is provided for science teachers during undergraduate preparation courses. Besides, few publications in Portuguese are available to offer a concrete background for teaching science to these students. In order to deal with these circumstances a specific class was proposed to teach Chemistry to a group of 18 secondary students with disabilities (Down Syndrome, mental retardation and hearing impairment) from a public school located in the countryside of Rio de Janeiro State. A group composed by one secondary school teacher and five undergraduate, pre-practise students, all of them receiving a specific grant for promoting their formation as Chemistry teachers, developed four specific low cost experiments to be applied in classroom[1]. For those special students, this was their first time hands-on experience with experimental chemistry. The experiments were: a small PET rocket propelled by alcohol (combustion + combustive); the conductivity of substances; a *chemical volcano* (combustion + oxidation); and *writing with electricity* (electrochemistry). The purpose of that experimental class was to use everyday low-cost material related to each of the five senses of the special students. This project clearly rised up the self-confidence of the students with disabilities and afforded a better comprehension of Science in general and of Chemistry in special. Besides, it contributed significantly to the chemistry teaching formation of the undergraduate students.

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THE IMPACT OF THE TEMPUS-PROJECT SALIS ON TEACHER TRAINING WITHIN THE EU-PARTNERS

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SALiS (Student Active Learning in Science) is an EU-TEMPUS project involving three EU countries – Germany, Bulgaria and Ireland – and three beneficiary countries – Moldova, Georgia and Israel. The purpose of the project is to introduce more inquiry-based and activity-based science education in the beneficiary countries, firstly into teacher training and then into the schools. This has been done through a programme of workshops involving teacher trainers, teachers and trainee teachers in the beneficiary countries. This has been supported by a website and by specially prepared teaching materials.[1]
While TEMPUS-projects often are structured as initiatives of knowledge transfer from EU countries to the TEMPUS area, SALiS understands itself as a collaborative activity to innovate science teacher education in the TEMPUS beneficiary countries as well as in the EU countries. In this intention, also the EU partners have benefited from this project in a number of ways. Through the creative work involved preparation and delivery of the workshops; through the preparation of teaching materials in a standard format, ready for translation into the various languages used in the beneficiary countries; and through incorporating ideas developed for the project in the institutions of the EU partners.
For example, in Ireland we have developed further the idea of using demonstrations to encourage thinking and inquiry in the classroom and have used it during an Irish chemistry teacher's workshop. It is also intended to disseminate these ideas through science teacher's in-service courses and conferences, as well as incorporating SALiS ideas into initial teacher training. Ideas and materials from the workshops have also been adopted by institutions in Bulgaria and Germany, and will be followed up by workshops for teacher trainers and teachers. Feedback from the participants in the workshops in the beneficiary countries has also been used to modify and create new materials for use all the EU-partner institutions. This cycle of creation, testing, evaluation, modification and dissemination has proved to be very workable and successful.

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A THEORETICAL FRAMEWORK FOR INNOVATING SCIENCE TEACHER EDUCATION WITHIN THE TEMPUS-PROJECT SALIS

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SALiS (Student Active Learning in Science) is a project funded within the TEMPUS program of the EU. SALiS involves partners from Germany, Bulgaria, Ireland, Moldova, Georgia and Israel. The purpose of the project is innovating science teaching by implementing modern and effective strategies in science teacher education. The focus of innovation is strengthening inquiry-based science education with a high degree of student activity, hands-on and minds-on.[1,2]

This presentation will introduce into the SALiS symposium covering presentations from Germany, Georgia, Israel and Ireland. The presentation will outline the theoretical framework of SALiS. On the base of this framework, science teacher training modules and materials were developed and applied in SALiS-trainings in all the beneficiary countries. Teacher training modules were implemented into the teacher training curricula in the beneficiary countries. The curricula will introduce prospective and in-service teachers to well established practices of inquiry-experiments, open labwork, problem-solving activities and forms of collaborative and cooperative learning. Innovations in the beneficiary countries were also touching reform by implementing infrastructure for more hands-on and laboratory activities in pedagogical course in teacher training, and implementing the culture of low-cost- and microscale-experimentation in science teacher training by equipping respective labs accordingly. Exemplary information will be provided about the selection of the chosen innovations. An overview on the resources developed will be given.

In the end a short outlook will be given, how these resources can be implemented also in other teacher training programs. This focus will be illustrated by the case of chemistry teacher training modules at the University of Bremen, Germany, and by insights into in-service training courses offered by the chemistry teacher training centre Bremen-Oldenburg, Germany, financed by the German chemical society (GDCh).

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THE IMPACT OF THE TEMPUS-PROJECT SALIS ON INNOVATIONS IN CHEMISTRY AND SCIENCE TEACHER TRAINING IN ISRAEL

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Since 2010, the Academic Arab College of Education (AACE) is one of the partners in the TEMPUS-project SALiS (Student Active Learning in Science) funded by the EU. SALiS aims at the expansion and enhancement of science education in formal education by innovating teacher training. The purpose of the project is to develop new teacher training materials and incorporate them into pre- and in-service training of chemistry and science teachers. The ideal is to develop and promote innovative teaching strategies and cognitive functions of teachers for the purpose of professional development.[1]

The presentation will discuss the role and impact of SALiS on realizing the vision of the AACE to more thoroughly promote science education in the Arab sector in Israel. The presentation will give insights how the project developed its potential for real breakthroughs in science teaching and teacher education for the Arab community in Israel. Points of reflection will be (I) the SALiS curriculum development and implementation, (II) establishment of the SALiS teacher training laboratory in Haifa, Israel, and (III) the development of new and innovative teaching materials for teacher training and classroom use.

Specific foci in this presentation will be the use of low-cost- and microscale experiments in science teacher training at AACE and the development of new teaching approaches for teacher training and school science education. The later innovations are done e.g. in the fields of magnetic liquids and the chemistry of nano-technology. Both areas will be reflected on their specific potential to innovate chemistry education in the foreground of the specific conditions of chemistry education in the Arab sector in Israel.

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THE IMPACT OF THE TEMPUS-PROJECT SALIS FROM THE PERSPECTIVE OF AN EASTERN EUROPEAN COUNTRY

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After the end of the Soviet Union time intended change still seeks to overcome a centralized and teacher-centered paradigm in science education in Georgia. National reforms ask for more student-active and problem-based science education under inclusion of students' hands-on and inquiry-based learning in the lab. Unfortunately, curricula, teaching materials and teacher training facilities are not well enough developed to support sufficiently the intentions of the reform.[1]
As a response the TEMPUS-project SALiS (Student Active Learning in Science) was established. The project is led by jointly by the Ilia State University in Tbilisi, Georgia, and the University of Bremen, Germany. SALiS aims at promoting science teaching through a better inclusion of student-active experimental learning in science classes. SALiS promotes inquiry-type lab-work as one of the foundations of modern curricular and methodological approaches in science teaching to reach higher order cognitive skills, a better learning of science concepts, and to enhance the understanding of the nature of science.[2]

With the help of the TEMPUS-program of the EU, innovation of infrastructure and teacher training were implemented in Georgia. New laboratories for chemistry and science teacher training were founded and equipped. Curricula were changed and the staff was trained to train teachers more thoroughly towards inquiry-based science education with more student activity, especially based on low-cost- and microscale-laboratory techniques.

The presentation will reflect the potential of the SALiS reform initiative for change in post-soviet countries in the case of Georgia. Experiences will be reported from the process of developing and implementing innovations in chemistry and science teacher training in Georgia, but also in a second post-soviet partner country: Moldova. Successes and desiderata will be discussed.

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TEACHING ABOUT 'STEVIA' – AN EXAMPLE OF COOPERATIVE CURRICULUM INNOVATION WITHIN PROFILES IN GERMANY

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It took a long time that 'Stevia' was approved within the EU to be allowed using it as a low-calorie-sweetener. But: What is Stevia? How can we inquire Stevia? Is Stevia a good sweetener? How were we dealing with the Stevia-debate in society? To whom might Stevia become a potentially attractive alternative? …

Developing and implementing innovative teaching materials incorporating a societal perspective on science education and compassing inquiry-type lab-work are among the aims of the FP7-project "PROFILES – Professional Reflection Oriented Focus on Inquiry-based Learning and Education through Science" founded by EU (1). Lead by the Free University of Berlin, PROFILES is built up by 21 partners out of 20 countries from all over Europe. The University of Bremen (UniHB), Germany, is one of them. Within PROFILES UniHB is operating a Participatory Action Research-based approach of curriculum innovation and professional development (2). Teams of science educators and teachers jointly develop and implement societal driven and inquiry-based lesson plans inspired by a socio-critical and problem-oriented approach to chemistry and science teaching (3).

This presentation will provide a short description of how PROFILES is driven in the case of the UniHB. It will be discussed how curriculum development and teachers' CPD are jointly operated. The work of PROFILES at the UniHB will be illustrated by the case of developing a lesson plan on sweeteners in general and 'Stevia' in particular (4). Exemplary insights will be provided how the cooperation of educators and teachers within PROFILES at the UniHB leads to the implementation of a different approach to chemistry learning. This approach aims on more student activity and the development of new teaching methods. In this case a method was developed to learn about the role of chemistry within the making of advertisings for science related products. Initial insights into the effects of the lesson plan will be presented.

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MAXIMIZING SCIENTIFIC THOUGHT THROUGH THE DESIGN OF A COLLABORATIVE RESEARCH-BASED ORGANIC CHEMISTRY 2 LABORATORY COURSE

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Converting a traditional organic chemistry laboratory course into a collaborative research-based course can be a daunting challenge especially if the goal is to maximize scientific thought. This talk will highlight the features of our research-based laboratory course that have proven to be most essential in provoking critical thought throughout its 10-year history. The role of the Organic Chemistry 1 laboratory experience in preparing the students for the research lab will be discussed as well as our two-project model where students apply in the second research project what they have learned from the presentation/critique session following the first. The talk will discuss what we've learned about the value of keeping the chemistry conceptually and practically simple as well as describing how our students use the research findings of previous students as a foundation for their chosen projects. Structured student/instructor interactions are an essential component of the course design and serve the purpose of stimulating critical thought before and immediately after data collection. Teaching assistants play a critical role in making these interactions possible. Results from pre and post tests given during the original NSF pilot project as well as results from recent surveys and student presentations will be discussed.

ARGUMENTATION IN THE CHEMISTRY LABORATORY

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One of the goals of science education is to equip students with the ability to rationalize and criticize arguments in scientific contexts. Over the past decade, many studies have been conducted on constructing arguments in science teaching, but only few of them deal with studying argumentation in the context of the laboratory. Our research was conducted on 11th and 12th grade chemistry students (six classes) in Israel and focuses on the process in which the student constructs arguments in the laboratory in various types of experiments (open-ended-type inquiry experiments and confirmatory experiments). It was found found that inquiry-type experiments can provide a platform for constructing arguments, due to the features of the learning environment. The discourse during the inquiry experiments was found to be rich in arguments, whereas the one during confirmatory experiments does not include argumentation components. The arguments developed during a discourse in an open inquiry experiment, focus on some of the inquiry-type skills, such as: (1) defining an assumption, (2) analyzing the results, and (3) writing the conclusions (Katchevich, Hofstein & Mamlok-Naaman, 2011). In order to characterize the inquiry experiments related to their potential to raise arguments several variables were examined: The complexity of the experiment, the congruence between the results of the experiment that the students performed and the hypothesis that they raised, and the questions that the students ask during the discourse. It was found that, in experiments classified as complex, the average number of arguments posed during the experiment is significantly higher than those posed in the experiments classified as comparatively simple. In addition, it was found that the complex type experiments provides a stimulator for asking question by the students. Furthermore, the average number of arguments and, the episodes of refutation in which unexpected results were obtained was signifacantly higher than the number obtained in the experiments in which expected results were obtained.

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LABORATORY UNDERGRADUATE RESEARCH EXPERIENCES: A LONGITUDINAL STUDY OF IMPACT ON LEARNING GAINS

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Undergraduate research is widely recognised as a pedagogical route to enhancing students' identities as scientists, raising students' awareness of the nature of science and improving the recruitment and retention of undergraduates[1,2]. In this study, as part of a curriculum reform through the introduction of active learning experiences, a laboratory undergraduate research experience (URE) was introduced as an alternative practical route in a large chemistry class to provide the option of an authentic practical experience in 2008. The research module comprised a three week skill-building phase where students acquired the skills required to embark on the subsequent three week research phase. This URE model has been demonstrated as enhancing students' scientific process skills and their understanding of the nature of science[1] and positive outcomes were observed on implementation[3].

In 2011, interviews were conducted with 25 students who had self-selected into the URE in their first or second year of studies to evaluate whether there were longer term learning gains that were directly related to the URE. Questions explored student perceptions of the impact of their URE on their practical skills, their decision to engage in further research, and their study paths. The outcomes of this study are presented in terms of the themes that emerged from interviews relating to learning outcomes, science identity, research skills, and career aspirations. Substantial evidence emerged to support that the URE experience in first-year chemistry had a significant impact on student confidence in their laboratory skills, engagement in experiments, working collaboratively and intention to pursue a research career.

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HOW DO INTERVENTIONS IN FIRST YEAR CHEMISTRY CLASSES AFFECT CRITICAL THINKING AND COMMUNICATION SKILLS?

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Students' evaluations of their development of critical thinking and communication skills in first year Chemistry courses have remained consistently low for a number of years. This is despite the inclusion of new active learning and assessment opportunities designed to encourage the development of these attributes. We were concerned to find out how students understand critical thinking and communication in chemistry and to explore these ideas with them. Students were questioned about their learning experiences and workload as well as the development of these skills in surveys and focus groups. The results have been collated and analysed and provided interesting insight, not just about the skills in question but about the courses as a whole. This influenced further development of the courses and the teaching strategies used. Student responses to the changes were again explored and have been collated and evaluated. The active learning strategies used, which include POGIL style worksheets, clicker questions, small group discussions and the introduction of prelaboratory quizzes based in videos of laboratory techniques, will be discussed. The results of the student surveys, how these have influenced the development of our courses and changes in student perceptions of their developing skills will also be presented.

STUDENTS' PROCEEDING IN REAL AND VIRTUAL GUIDED INQUIRY ENVIRONMENTS

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In recent years, many studies have had a look at what students do when working in inquiry environments (e.g. Hart et al., 2000). Main findings were that working on inquiry tasks is complex, and students have to learn how to inquire, i.e. the steps to be taken, how these steps interact, and how to tackle problems. Based on the results, a number of intervention programs have been created and evaluated.

Klahr and Dunbar's *SDDS*-model (Scientific Discovery as Dual Search) claims two key elements: Generating ideas based on prior knowledge in the *Hypothesis Space (HS)*; and testing the ideas in the *Experiment Space (ES)*. Empirical data shows that work is most fruitful if there is an interaction between what is been done in HS and ES (Klahr, 2000).

Since studies usually either focus on virtual labs or real labs or compare both, there is not much available information on a promising combination of both. Nonetheless, each mode (real and virtual) indisputably has its advantages, and can foster aspects of inquiry the other one cannot.

Thus, a pre-post intervention study was created in which pairs of students (N=211 pairs; Year 8 students, Higher Secondary School) worked on two different topics successively (A: Acids and Bases; B: Buoyancy). The treatment groups vary in the modes of the environments:

Table 1: Treatment Groups

Group	1	2	3	4
Mode of 1st Topic	Virtual	Real	Virtual	Real
Mode of 2nd topic	Virtual	Virtual	Real	Real

To avoid effects of order, subgroups were created: half of each group's pairs started with topic A, half with topic B. As the environments are based on the *SDDS*-model, students were asked to note the ideas (HS) and experiment with the given material (ES). As far as possible, the materials in both modes of a topic were the same. To give students a chance to familiarize with the environments, standardized introductions were given. For each topic, students had 20 minutes of time on task. Various aspects of inquiry were tested in paper-pencil tests, with additional hands on-tasks using the real environments' materials. Additionally, process data was recorded (videos of students working on real environments, and logfiles of the work on the virtual environments).

There are no treatment effects observable. At the moment, a plotting method and coding manual is being developed which can be used for both types of process data. Results will be available in summer 2012.

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INQUIRY-BASED LEARNING ENVIRONMENTS TO WELCOME DIVERSITY IN CHEMISTRY CLASSES

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To renew science education the European Commission (2007) demands the implementation of *inquiry-based learning*. It is a method which has empirically been found as being effective with gifted as well as disadvantaged children (ibid., p. 12). This demand is even more relevant because of the UN convention on rights of persons with disabilities (United Nations, 2006) requesting an inclusive education system which a lot of countries signed and some also ratified (http://www.un.org/disabilities/countries). Nevertheless, the way of handling difference and diversity remains one of the biggest problems in European classrooms (Meijer, 2010).

To face these challenges *learning environments* – arrangements of methods, techniques, materials and media (Reinmann & Mandl, 2006) – have to be adapted. For a suitable learning environment for inquiry-based learning a special way of scaffolding (Furtak, 2008), material arrangement and tasks have to be provided. In such an environment the students get the opportunity to work autonomously, develop competencies and relatedness (Ryan & Deci, 2000). The implementation of inquiry-based learning into classes requires an often unfamiliar and challenging role of teachers (Furtak, 2008, van der Valk & de Jong, 2009).

Two *inquiry-based* case studies will be presented exemplifying ways of implementing inquiry-based learning in diverse chemistry classes. It will be shown that the different learning needs of the students are not considered "as a challenge to be dealt with actively" but "as a resource for individual and mutual learning and development" (Sliwka, 2010, p. 213f). The concomitant research (qualitative designs) will be presented as well.

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REFINEMENT AND ANALYSIS OF QUESTIONNAIRES ON STUDENT PERCEPTIONS AND ATTITUDES TOWARDS CHEMISTRY LABORATORY TRAINING USING THE RASCH MODEL

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Laboratory training plays an important role in the teaching and learning of Chemistry. Research suggests that laboratory work has an impact on enhancing student attitudes towards science; stimulating interest, enjoyment and motivation of science learning[1,2] and thus the focus of our research is to investigate student perceptions and attitudes towards first-year General Chemistry practical training and how these change throughout the year. Although literature indicates the presence of several similar studies, the majority of science attitude test instruments show an absence of psychometric evidence and have several methodological issues including the absence of reliability, validity and a disregard for missing data[3]. We therefore felt the need to develop our own test instrument that addressed these concerns. This paper deals with the development and refinement of our test instrument by using the Rasch Latent Trait model which is a probabilistic model working on the assumptions that underlying traits are present[4] and that the raw scores obtained from the instrument are non-linear in nature and thus to be converted into linear measures[5]. The Rasch model is ideal to evaluate an instrument's reliability and validity[5]. Rasch analysis of our questionnaires indicated that several items did not fit the model leading to closer inspection of those items. Firstly it was found that there were two latent traits present instead of the expected one and secondly we found that two of the items contained similar components possibly causing contextual confusion. With this valuable information gained from Rasch analysis the questionnaire has been improved and refined and will be used for collection of data througout this year. The test instrument will again be checked for internal consistency as well as comparison of results drawn between the different questionnaires using the Rasch model. Some of the results from last year's study has indicated that students found the second semester of Chemistry practical training to be harder than the first. Enthusiasm levels stayed the same througout the year while students felt less frustrated by the end of the year. Students least endorsed "development of time management skills" as an outcome for Chemistry training.

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A VIABLE APPROACH TO THE INTERPRETATION OF ^{1}H NMR SPECTRA OF ORGANIC COMPOUNDS

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Interpretation of ^{1}H NMR spectra is one of the most significant skill any chemist can acquire because it is useful in the identification of the structure of organic compounds. Teaching students NMR spectroscopy is a complex task, because "There is no completely rational or reliable strategy for solving structures from spectroscopic data. The precise route to a structure will depend on how much background and spectroscopic information is available about the molecule, and on which of the spectra appear most useful."[1] Nevertheless, mastering NMR spectroscopy is an important ability for chemistry students because "NMR spectroscopy is arguably the most important analytical method available today. The reasons are manifold: it is applied by chemists and physicists to gases, liquids, liquid crystals and solids (including polymers)."[2]

At KAU, organic spectroscopy course (333) is taught to third- and fourth-year students. It presents challenges for students as well as instructors because too often, students come to this class with the idea that spectral data, primarily NMR, is difficult to comprehend and spectra are almost impossible to interpret and solve. An effective and proved to be very helpful approach to help students digest the fundamentals of ^{1}H NMR spectroscopy and, hence, become capable of solving spectra of unknown compounds is by incorporating, smoothly, an atmosphere of thoughtfulness to the classroom. This was accomplished by introducing, simultaneously, the skill of problem solving along with cooperative learning technique into the course content.

The students digested the spectral concepts, and their acceptance of the proposed approach was meaningful. This was reflected on the strategy they used to abstract spectral data presented in ^{1}H NMR spectra and applied it efficiently to, partially or completely, interpret a spectrum and elucidate the structure of an unknown with the least amount of errors. Moving along the course and repeatedly applying this technique, the students learned and developed the skill of problem solving to use it personally and professionally to gain a deeper understanding of one of the important analytical tools in chemistry.[3]

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VISUAL STUDY OF LIGHT INTERACTION IN PHOTOCHEMICAL REACTION OF DYES

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This article describes the visual interaction of light in photochemical reaction of dyes. For this purpose Starch and sucrose with methylene green in alkaline medium were chosen which found to be best for the display of interaction of light in photochemical reactions of dyes that are initiated by the absorption of light radiation. When a mixture of 10 ml 10 % NaOH, 1 ml dye (0.0182) and 5 ml of 2% starch and sucrose were placed in a dark no color change was observed but when reaction mixture were placed in light, blue color was turned into purple then decolorized. This reflects that a photochemical reaction can be explained visually to undergraduate student through BLUE BOTTLE EXPERIMENT where the color transitions due to the absorption of radiation occur. This experiment also demonstrates the transition of delocalized electrons within dye molecule due to the absorption photon of light in reaction and dye reduced to semi reduced and completely reduced dye.

Key words: visual, light, photochemical reaction, Starch, sucrose, methylene green

TEACHING CHEMISTRY IN THE POST-CRYSTALLOGRAPHIC ERA

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The slightly provocative title of this paper is intended to express the feeling that, due to enormous technical and methodological developments in the field of x-ray structure analysis it has become an every-day need and experience of chemists, especially synthetic chemists. Elemental analysis, once a must after each synthetic procedure, is often replaced simply by x-ray structure work which requires minute amounts of sample, of the order of few micrograms (which are not destroyed during the analysis !).

In this context curriculum in chemistry teaching should be adapted. First, extensive programs of classical crystallography may be moved to specialized courses only whilst chemistry curricula need comprehensive curriculum of 'understanding x-ray data'. This novel part may be welcome by chemistry students since it is associated with extensive use of computer graphics, user friendly software etc.

Of particular importance is teaching symmetry, both at the molecular and the crystal level. This is a prerequisite for understanding results of structural studies but, to the author's experience, this seems to be a weak point in the hitherto education system. Second, statistical analysis of the results needs to be understood by chemists, which is rarely the case. And, analysis of thermal motion of molecules or their rigid fragments, provides much of chemical information which is, so far, routinely ignored.

And, finally, chemistry curricula need to be implemented by some elementary knowledge on the solid state, its characteristics as compared to the single molecule level. Again, it is the author's opinion that chemistry students have little, if any, knowledge on the collective phenomena in condesed systems.

All the above mentioned gaps in chemistry education can easily be filled-in by introducing novel courses of 'undestanding structure data' replacing traditional crystallography. It is a must nowadays when table-top single crystal diffractometers became a reality and most of the routine x-ray structure analysis will soon be performed not by expert crystallographers but by ordinary chemists.

Explanation of the major breakthoughs in x-ray crystallography, as well as the proposed new curricula in this respect will be given.

USING SPECTROSCOPY LABORATORY EXPERIMENTS TO FACILITATE LEARNING IN CHEMISTRY LECTURE

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Spectroscopy is a useful tool as an introductory learning model for general chemistry students. The interaction of light with matter enables students to gain a wide variety of information from excited molecules based on chemical theory. The goal of laboratory is to have visual experimental results that enable students to draw conclusions about chemical interactions on the qualitative and quantitative levels that enhance learning in lecture. Chemical experiments using spectroscopic methods enable students to immediately see trends of chemical absorption of light by varying concentrations of a chemical compound versus the level of absorption of light or through the interpretation of a generated spectrum of the molecule. Acree has developed a series of experiments for students in the *Modern General Chemistry Laboratory* manual for undergraduates at the University of North Texas that incorporate using computer technology as well as spectroscopy for the teaching laboratory. By integrating computer technology into the laboratory, chemical relationships can be immediately seen with linearity in classic chemical theory and spectroscopy. Students can then be introduced to calculations that determine chemical properties therefore encouraging higher learning. Since only little preparation time is needed, and immediate results are seen in the spectroscopy experiments based on absorption and transmittance measurements, the quick generation of spectra enables students to have a hands-on learning experience with a gross understanding of the chemical theory that in turn facilitates their understanding in lecture.

UNCOVERING CHEMICAL SECRETS – AN INTEGRATED APPROACH TO ACCESSING UNIVERSITY INFRASTRUCTURE IN THE SUPPORT OF SECONDARY EDUCATION

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Practical based learning in schools has been eroded by pressures of new curricula, perceived health and safety constraints and lack of resources. Practical chemistry motivates young people and its erosion damages the perception of chemistry and career opportunities

We have developed 'hands-on' workshops for students which are focused directly at topics within the secondary-level curriculum using advanced techniques and modern equipment which teachers have identified as the most difficult or challenging to teach.[1] Some topics in the curriculum include techniques and equipment that are not available in schools but are common in universities and a key principle behind the workshop is to enable students to see how these techniques and equipment are operated and how data (spectra) are obtained in reality, and using their own samples.

Our workshop is based upon a series of practical exercises involving the isolation of a range of natural products demonstrating 'extraction', 'purification' and 'qualitative analysis'.[2] Students see spectroscopic methods using their own samples which are explained during the workshop. A detailed and comprehensive ICT resource covering background theory, analysis and spectra is provided on DVD for teachers to use in school. The DVD can be used as a stand-alone resource and has been enthusiastically received by a number of schools throughout the UK.

Students experience a modern university chemistry department and working environment in the context of a curriculum focussed exercise. The programme is enthusiastically received by teachers and students alike and has been routinely oversubscribed. In 2011, 300 A level chemistry students from the local catchment area attended.

The ICT resource received financial support from the Higher Education Funding Council for Wales and contributed to the RSC's "Chemistry for the Future" (CFOF) national programme to promote chemistry.

Two 'spin-off' projects are in development and nearing completion. These include a new e-learning resource on UV-Vis spectroscopy and key transition metal chemistry developed as a second DVD which will be available to schools from September 2012. The educational quality and visual attractiveness of these materials has also attracted the RSC to commission us to provide the resources behind their new project for secondary schools, 'Spectroscopy In A Suitcase' in which portable spectroscopic equipment can be taken into secondary schools for students and teachers to use in-house.

Comprehensive details and operational aspects will be presented along with an illustrated talk explaining the development of the resources which supports the programme.

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EXPLORING SENIOR SCIENCE STUDENT TEACHERS' VIEWS OF ENVIRONMENTAL ISSUES IN 'ENVIRONMENTAL CHEMISTRY' COURSE: A PRELIMINARY QUALITATIVE STUDY

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To enable the students to capture competencies of "scientific inquiry", several models, i.e. Technology Embedded Scientific Inquiry (TESI) suggested by Ebenezer et al. (2011), have been released. The TESI model includes three interactive dimensions: Technology Embedded Scientific Conceptualization, Technology Embedded Scientific Investigation and Technology Embedded Scientific Communication. In this current study, "Environmental Chemistry" elective course was employed as a vehicle to train senior science student teachers (SSSTs) and also to investigate effectiveness of the TESI model in this context. However, this study only contains some parts of qualitative data from a preliminary study named pilot study. The aim of this study is to explore SSSTs' views of environmental issues such as pollution, the types of pollution, the relationship between the types of biochemical cycles and environmental chemistry, the quality of the water, the relationship between water refinement and environmental chemistry, the causes of water, air and soil pollution etc. in the context of environmental chemistry course. For this reason semi-structured interviews with 10 open-ended questions were used to collect data. Each interview session, in which a slide show incorporating in environmental chemistry pictures for each principal question was initially displayed, lasted about 40-45 minutes. Apart from the principal questions for environmental issues, some follow up questions were also asked to clarify some unclear views or get a deeper exploration. In analyzing data, each interview session was transcribed and then exposed to a content analysis by forming themes and codes. The findings of the study revealed that the SSSTs had some deficiencies about environmental issues, i.e., environmental pollution, the relationship between the quality of the water and water refinement and the role of the environmental chemistry in this relationship. Moreover, the preliminary study suggests that some minor revisions are necessary to conform the principal questions into phenomenograpfic approach. Further, new questions measuring the SSSTs' views of the TESI model and its application should be added into the interview questions.

Key words: Environmental chemistry, senior science student teachers, scientific inquiry, technology embedded scientific inquiry

SOIL EXPERIMENTS FOR CONTEXTUALIZING ENVIRONMENTAL SCIENCES FOR SECONDARY STUDENTS

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Brazil has a very great diversity of soils with different properties and applications in agriculture. The appropriate use of soil however should involve sustentability and social concern. Several aspects regarding degradability of soils should involve interdisciplinarity and transdisciplinarity[1]. Chemistry, Biology, Physics and Geology concepts should be discussed in order to make students understand the multiple aspects of soils, as well as their use and importance for humanity. The discussion of this subject in secondary schools in a global and also in local perspective is of great importance for the formation of conscious citizens able to make future decisions that affect both their neighboorhood as well as a more sustainable world.

This work has the objective to propose and ellaborate working environmental groups with secondary students on Soils. In this context we propose experiments involving analysis of properties of soils and their use in growing a vegetable garden. We developed these experiments with first and third grade secondary schools as well as nineth grade students from a public school in Araruama district, which is more than 100 km far from the city of Rio de Janeiro. The proposed experiments were the following: kit pH of Soils and kit Vegetable Gardens.

In Kit pH of Soils we first discussed the fundamentals of acidity and basicity of different types of soils and their importance for agriculture. Afterwards, students mediated by teachers have analysed pH of soils using different indicators, both chemicals and vegetables.

For the Kit Vegetable Gardens the following steps were done: 1- Discussion with students using a science-technology-society (STS) approach involving preparation and use of organic fertilizers, 2- Analysis of pH of soils, 3- preparation of soil with organic fertilizers, 4- Sowing of seeds in small compartiments, 5- Transportation of plant seedings for the vegetable garden.

After the experiments, the students orally presented their results and discussion in groups.

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PROSPECTIVE CHEMISTRY TEACHERS' IDEAS CONCERNING GLOBAL CLIMATE CHANGE, OZONE LAYER DEPLETION, GREENHOUSE EFFECT AND ACID RAIN: ARE THEY SCIENTIFICALLY ACCEPTABLE?

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Environmental issues have become a major problem that our world faces and it threatens not only the world but also the individuals' health. There is a need for individuals who have knowledge about the causes, consequences and cures of this serious problem. The way to do that to raise environmentally literate people and this is the reason behind the emphasis for environmental education programmes. Yet, empirical studies indicate that students' ideas are severely limited and their understandings are embedded with a range of alternative conceptions (Boyes & Stanisstreet 1993; 1998). Prospective and in service teachers also have inadequate and alternative ideas of the same environmental problems (Dove, 1996; Groves & Pugh, 1999; Michail, Stamou & Stamou, 2007). Therefore, we decided to conduct this study to illustrate a bigger picture of prospective teachers' ideas of the environmental problems listed above.

The aim of the study is to examine the ideas that prospective chemistry teachers (PCTs) have about the causes, consequences and cures of global climate change, ozone layer depletion and acid rain. This study was constructed in the light of constructivist/interpretive paradigm and a survey design was benefited. An open ended questionnaire was developed and used in the study. In this way, it became possible to see students' individual ideas rather than determining their tendency to agree with the statements provided. In these questions, the PCTs were asked to define various environment concepts such as greenhouse effect, ozone layer depletion, climate change, acid rain and so on, the relationship between these concepts, to draw their mental images of the ozone layer depletion and possible reasons and cures of environmental problems. 150 PCTs who took environment courses during their education programme participated. The results of the study showed that the PCTs held some serious alternative ideas. They linked environmental problems which were irrelevant with cause-effect chain. Most of them (60%) thought that global climate change was the result of depletion and acid rain. Findings also indicated that the majority of them (95%) imagined ozone layer depletion as a hole, thinning or fracture, instead of decreasing of gas concentration.

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THE CHEMCOLLECTIVE: VIRTUAL LABS AND TUTORIALS FOR INTRODUCTORY CHEMISTRY

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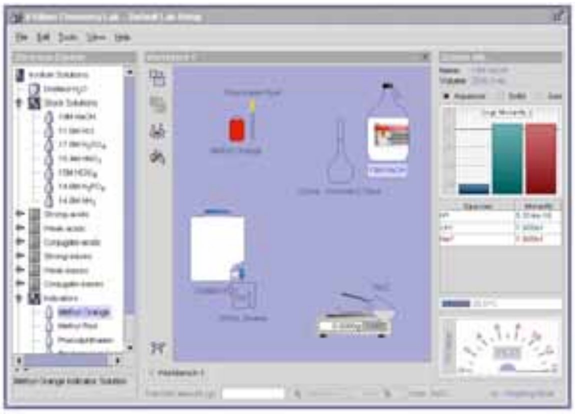

The ChemCollective virtual lab (www.chemcollective.org) is an open-ended learning environment in which students design and carry out their own experiments, while experiencing representations of chemistry that go beyond what is possible in a physical laboratory. The goal is not to replace or emulate the physical laboratory, but rather to supplement textbook problem solving by connecting abstract concepts to experiments and real-world applications. The lab provides a flexible means for authoring of learning activities, and more than half of the one hundred existing activities were contributed by the user community. The software is available in over thirteen languages and about 175,000 students perform an experiment in the virtual lab each year. Results from a number of learning studies will be summarized, to highlight how engaging students in the design and interpretation of experiments can enhance learning.

The ChemCollective also has a collection of tutorials, including a set that illustrates a new approach to chemical equilibrium instruction that has been shown to more than double student performance on difficult chemical equilibrium problems[1,2]. This new approach is based on a number of studies that exposed "tacit knowledge" in chemical equilibrium. Such tacit knowledge is obvious to experts and so instruction fails to make it explicit to students. One such class of tacit knowledge relates to chemical reactions being rules that, when applied to a collection of molecules, generates a progress-of-reaction coordinate. The other such class of tacit knowledge is that analysis of chemical equilibrium systems occurs in two phases, the first of which determines the concentration of majority species in the solution and the second of which determines the concentrations of the minority species.

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SIMULTANEOUS ELECTROCHEMICAL PROCESSES IN THE LABORATORY

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Many electrochemical processes have traditionally wasted one half of their energy usage by focusing on the reaction only one side of the cell. Modern trends tend to use both sides by judiciously designing complementary processes. We have worked on model reactions to this effect that can be performed in regular laboratory sessions and with rather simple equipment.

Examples include, but are not limited to:

a. Electrocoagulation. An iron anode produces Fe^{n+} ions while water is reduced at the cathode, yielding OH^- ions. When these products meet in the solution, a tridimensional gel of iron oxy-hydroxides forms that is capable of adsorbing a wide variety of pollutants. This can be removed from the solution by simple filtration.[1]
b. Recovery of a chelating agent (e.g., EDTA) and a metal (e.g., Cu) from a metal removal process. Complexation is used for remediation purposes. We developed an experiment in which one can simultaneously recover EDTA by acidification at the anode of a cell, and the metal by reduction at the cathode. Speciation diagrams are developed.[2]
c. Photocatalytic recovery of a metal ion and destruction of an organic pollutant. By supra bandgap irradiation of a suspension containing TiO_2 the generated holes oxidize an organic species (e.g., citric acid) and the electrons reduce a metal ion (e.g., Cu(II)).[3]
d. Simultaneous electroluminescence. Excitation of a luminophore (e.g., luminol) by an electric field produces anodic luminescence. We have developed a simultaneous indirect cathodic process by which chlorite ions are reduced to hypochlorite, which oxidizes the luminophore and brings about it characteristic blue light emission.[4]

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SELECTED GREEN BROMINATION EXPERIMENTS SUITABLE FOR PRACTICAL ORGANIC CHEMISTRY CURRICULUM

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Research on green bromination method became an essential and integral part of green organic chemistry curriculum. Although recently, green chemistry concepts are being taught all over the world, laboratory course based on green chemistry experiments are very few. All we know that many of the conventional laboratory experiments are involved in use of toxic materials. In the era of sustainable chemistry for environment protection this is highly undesired. So the need of the time is not only to develop but also to practice green chemistry experiments within the chemistry laboratory curriculum replacing the unsafe/hazardous experiments and conventional toxic chemicals as much as possible. Thus, the design of safe green experiments for laboratory curriculum and also to transit the message of green chemistry among the new generation chemists is highly desirable. In India studies on green chemistry also started. Effort on research is more in compare to curriculum development on green chemistry concepts. This paper describes the redesign of suitable green chemistry lab-experiments based on green bromination of organic substrates. Few green bromination methods have been purposefully selected to allow investigation of organic chemistry concepts and techniques in a greener laboratory setting. Green bromination processes are re-designed from standard literature methods to suitably modify and adopt in the organic chemistry laboratory courses. The conceptual themes and experimental techniques of redesigned green bromination experiments can be adopted in lab-curriculum to teach modern practice of organic chemistry in context of environmental impacts of chemical processes. Students will practice with these green techniques and acquire the knowledge to assess the health and environmental impacts of chemical processes which in-turn also encourage them to improve/ develop new green laboratory processes in future. Details of modified Methodologies, green chemistry concepts involved, chemicals/ reagents/materials used, and implication of green lab-experiments based on bromination in the main frame of organic chemistry laboratory curriculum will be presented.

TRAINING UNDERGRADUATES TO "THINK GREEN"

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Although the 2011 International Year of Chemistry is over, one of its central themes (to "make a strong educational contribution toward the goals of the United Nations Decade of Education for Sustainable Development")[1] must surely continue. This can be achieved by development and implementation of novel, green pedagogical materials across the chemistry undergraduate curriculum. As noted by a group of graduate and post-doctoral students over five years ago, "our education would have been significantly enhanced with the incorporation of green chemistry, beginning at the elementary level and continuing throughout graduate coursework[2]."

At the University of Toronto we have designed a modern, cutting-edge course for organic chemistry undergraduates focusing on green chemistry principles. Over 200 students have taken this course over a five-year period. *"Green thinking" takes place in a laboratory environment where forefront research, primarily in the field of catalysis, is the driver for practical work.* Students are exposed to greener approaches in terms of solvent elimination, use of water as a reaction medium, energy-efficient transformations and catalytic reaction strategies. They are able to quantify and assess different routes towards the same compound from a sustainability perspective. The "capstone" experience requires students to plan their own synthesis of a target substance whilst making it as green as possible. This provides excellent, essential training and preparation for graduate school and subsequent industrial positions.

This presentation will describe the evolution of the course, its impact on undergraduate curricula and the development of a unique "Synthetic and Catalytic Chemistry" program at our institution.

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INNOVATIVE SCHOOL-LEVEL QUANTITATIVE CHEMISTRY EXPERIMENTAL TECHNIQUE (I) [1]

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Quantitative experiments of physical science and social science are designed by the instruments adopted. Instead of using different scientific instruments for a variety of experiments, it would be convenient if a single piece of instrument can be used for more than one type of experiment.

The "DMM display" technique employs commercial low-cost digital multimeter (DMM) to act as a common display instrument for quantitative measurements of (i) pH (ii) solution conductance and (iii) colour intensity of aqueous solutions. Principle of measurement is based on probes for these reactions output d.c. electrical signals which can be nicely handled by the high-input resistance of such kind of DMM involving voltage (e.m.f.) measurements.

The paper will introduce principles of pH measurement by antimony electrode [2], use of the mini "salt-plug" and details for the construction of the electrodes and sensor (Models A and B).

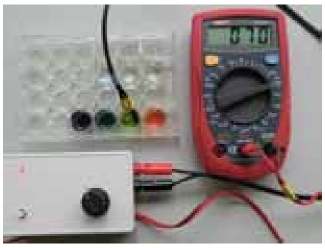
The "DMM display" technique works for measurements of conductance and colour intensity as well as pH, provided that suitable sensors are used.

(A) pH measurement using antimony electrode (Direct reading model)

pH measurement is essentially chemical cell e.m.f. measurement. pH display using the voltage range of a DMM is done by an electronic sensor which limits measured cell e.m.f. to a fixed amplification ratio such that pH readings can be displayed directly by the measured e.m.f.

Instead of glass combination electrode, a low-cost antimony/copper-copper(II) sulphate reference electrode incorporating an innovative mini "salt-plug" is used for pH measurements. Raw e.m.f. generated by the chemical cell formed is summed (corrected) against a built-in voltage reference of -0.05 V at the non-inverting input of a linear Op Amp [3] to obtain a zero pH (in) / zero mV (out) condition so that pH can be made directly proportional to e.m.f. measured. Calibration with buffer is achieved by adjusting amplification of the corrected e.m.f. such that an output of 10 mV per pH is allowed to be fed to the voltage range of a DMM.

Sb and Cu/$CuSO_4$ electrode (with "salt-plug")



pH measurement assembly

Homemade pH sensor

(B) pH measurement using antimony electrode (Basic model)

This method involves only the antimony/copper-copper sulphate electrode and a DMM. Calibration is done without a sensor by a linear plot of e.m.f. vs pH of buffer. Raw e.m.f. measured is converted to pH values by a suitable spreadsheet software involving regression.

Keywords: Instruments of statistical methods, pH measurement, input offset of Op Amp, summation by Op Amp, voltage amplification, salt bridge of chemical cells, regression line

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AN INTRODUCTION OF MODERN RESEARCH TECHNIQUES TO THE UNDERGRADUATE ANALYTICAL CHEMISTRY LABORATORY: DEVELOPMENT AND IMPLEMENTATION OF A MICROFLUIDICS LABORATORY MODULE

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Over the past two decades, miniaturization of analytical instrumentation has become a dominant trend. The development of microfluidic devices is clearly one of the forerunning themes in analytical chemistry research as indicated by the evolution of dedicated journals, conferences and symposia. While undergraduate students are now being exposed to concepts of microfluidic design and operation in lectures, little has been reported in the chemical education literature to support the notion that undergraduate students are being provided with hands-on exposure to this rapidly developing technology and its applications to research problems that are encountered in analytical chemistry.

The outcomes of work done to develop and implement an advanced undergraduate laboratory module that focuses on microfluidic device fabrication, characterisation and practical application of such devices to better teach the theoretical aspects of microfluidic systems will be presented. The design of the core components of the module will be discussed, namely:

- Practical Skills Development for the Fabrication of Microfluidic Devices: Template Design, Preparation of Castings, Characterisation by Scanning Electron Microscopy and Device Assembly.
- Learning About Fluid Flow in Microchannels: Investigations of Electroosmotic Flow Velocity and Zeta Potential Determination.
- Learning About Mixing in Microchannels: Péclet Number and Diffusion Coefficient Determination.
- Device Construction and Testing: Microchannel Electrophoresis with On-Line Fluorimetric Detection for the Separation and Analysis of a DNA Ladder.

Feedback received from students that have completed these experiments and improvements made based on student input will be included.

KINETICS OF OXIDATION OF SOME CARBOHODRATES BY CHLORAMINE-T WITH PHOTOCHEMICALLY GENERATED RADICALS

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Carbohydrates are the essential biomolecules and a chief source of energy for living system. The oxidation of carbohydrates and fats in living system is a free radical reaction and we get energy from these exothermic reactions. Thus the oxidation of carbohydrates is a basic source of life. In order to understand the mechanism of oxidation of carbohydrates, a systematic kinetic study of oxidation of glucose and lactose with photochemically generated radicals was carried out using chloramine-T as an oxidising agent. The reaction has a first order dependence on [chloramine-T] as well as on [substrate]. The reaction is catalysed by H^+ ions as well. On the basis of kinetic results and product analysis a probable mechanism was suggested.

Key words: lactose, kinetics, photochemical oxidation, chloramine-T.

ANALYSIS OF THE AMBIENT AIR QUALITY AND RESPIRATORY MORBIDITY: THE CASE IN TARLAC CITY, PHILIPPINES, 2009-2010

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This study aimed to monitor the level of air pollutants in the ambient air of Tarlac City. Samples were collected from different parts of the city to evaluate what area of the city (categorized as to: Station 1-highly active interchange, Station 2- bus interchange, Station 3-city center hub, and station 4- school community) has the highest level of pollution. The results were compared and interpreted based on the standard procedures specified under Republic Act 8749 otherwise known as the Philippine Clean Air Act of 1999. Total suspended particulates at stations 1 (over by 547.77µg/Ncm), 2 (over by 41.01 µg/Ncm), and 3 (over by 150.51µg/Ncm) exceeded the maximum allowable limit as described in the DENR standard. This may pose an unhealthy environment particularly to people with respiratory ailments such as asthma and allergies. Among the four stations, Station 1exhibited the highest levels in terms of TSP, NO_2 and CO.

KEYWORDS: Environment, Ambient Air Pollution, Monitoring, Environmental Management Plan

MICROSCALE CHEMISTRY FOR ATTRACTIVE CHEMISTRY CLASS

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Over the past two decades, there has been a worldwide initiative in developing microscale chemistry (MC). Implementation of MC in laboratory teaching results in a variety of advantages such as saving cost of chemicals and time for preparation, elimination of the risk of fire or explosion danger, reduction of waste and creation of the sense of green chemistry. There are many other significant bonuses: the learning experience of students can be enriched, and students' interest in chemistry could be stimulated. However, MC is not just miniaturizing conventional equipment or reducing amount of reagents used, more importantly, there should be some innovation and creativity to make the MC experiments more attractive than the ordinary scale ones. We have been working to develop attractive MC experiments. These experiments cover various basic topics. One example is a series of electrochemical experiments with a wellplate [1]. Various electrolytic and galvanic cells can be assembled easily on the plate in a short time. Experiments on Faraday's law and Nernst equation can be carried out also on a plate. Another example is a series of experiments on ion exchanger [2]. Through these experiments, students can learn the principles of ion exchange, some chemical behaviors of complex ions and application to analysis of some metal ions. All the experiments can be carried out in a short time. For example, our microscale Hoffmann electrolysis can be finished in 10 minutes with only 3 mL solution.

Visual observations and actual experiences are very important aspects in introductory chemistry. As chemistry covers atoms and molecules that cannot be actually seen or felt, it is difficult for most secondary school students to understand chemistry without experimenting. However, the number of experiments in chemistry has actually continued to decline in Japan, and the generation educated in such an environment now makes up much of secondary school teachers [3,4]. As the results, chemistry has become the least popular subject among all subjects. We have been working to activate chemistry classes to be attractive ones by introducing microscale experiments.

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MICROSCALE EXPERIMENTS ON DETERMINING DENSITIES OF ETHANOL-WATER MIXTURES

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The microscale experiment on decreases in volume when forming ethanol-water equivolume mixtures has been investigated [1]. In this study, the microscale experimental procedure of determining the densities of ethanol-water mixtures (0-100 mass% of ethanol) is developed using an electronic balance (± 0.01 g) and a 5-mL graduated cylinder.

The determination of a sample density at room temperature is as follows: First, the mass of a cylinder is measured. Secondly, a sample liquid in less than 4.9 mL is placed in the cylinder, and its volume V is measured. Thirdly, the sample mass m is measured (Subtracting the mass of the cylinder). Finally, the sample density d is determined using the formula: $d = m/V$. The observed densities are summarized in Table 1.

Table 1 Densities of Ethanol-Water Mixtures (in g·mL^{-1})

mass%	0.00	10.0	20.0	30.0	40.0	50.0
Observed*	0.991 ± 0.001	0.978 ± 0.001	0.962 ± 0.001	0.943 ± 0.001	0.927 ± 0.001	0.906 ± 0.001
Ref. [2] **	0.99705	0.98040	0.96636	0.95064	0.93145	0.90982
mass%	60.0	70.0	80.0	90.0	100	
Observed*	0.888 ± 0.001	0.859 ± 0.001	0.832 ± 0.001	0.805 ± 0.001	0.779 ± 0.001	
Ref. [2]**	0.88696	0.86337	0.83908	0.81360	0.78504	

* at room temperature, *at 25°C

The observed densities are in agreement with the reference data [2] within two significant figures. The volumes of samples are reduced by less than 1/5 in comparison with the traditional experiment [3]. Molarities [4] and excess molar volumes [1] are also estimated over the whole concentration range using our density data, and they are both satisfactory. In conclusion, it has been found that our methods of determining densities are useful for high school science.

This work is partly supported by a Grant-in-aid for Scientific Research (C) 20500748 from the Japan Society for the Promotion of Science.

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SELF-MADE GLASS TUBES REACTORS FOR SCHOOL ORGANIC SYNTHESIS

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Organic synthesis requires sometimes expensive reagents and equipment. Meanwhile the products of synthesis usually are thrown away. It means that for school organic synthesis small amounts of reagents are needed. But then they will get smeared on the walls of the vessels. We use tube reactors. They bare made of glass tubes with inner diameter ~5-6 mm by several blower operations alternating with charging by reagents. It allows working with about one gram of reagents that is enough to make quantitative reactions with products and to smell them. Small amounts of substances and high surface/volume ratio of small reactors facilitates cooling them when necessary. These reactors are very cheap and thus throwaway.

The simplest reactor is long tube sealed at one end. It is used to heat reaction mixture for a quite long time (for example, for esterification). The vapours are cooled in the upper part of the tube by air or wet tissue. When necessary the upper part could be cut off and the products poured wherever it is necessary. 1-shape reactor (Fig. 1) is used for thermal decomposition of substances (decarboxilation, synthesis of ketones from calcium carboxilates etc) condensing products in a test-tube. Reactor at Fig. 2 is used for catalytic decomposition of vapours (for example for alcohol dehydratation).

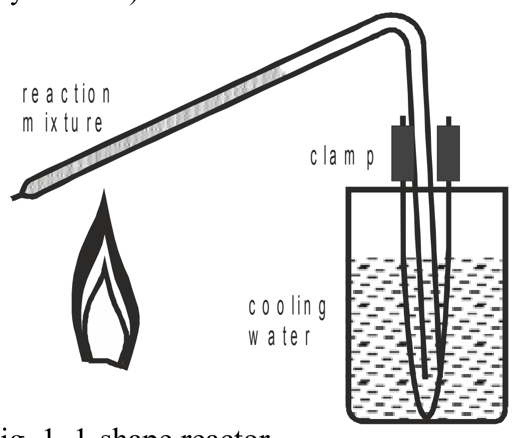

Fig. 1. 1-shape reactor

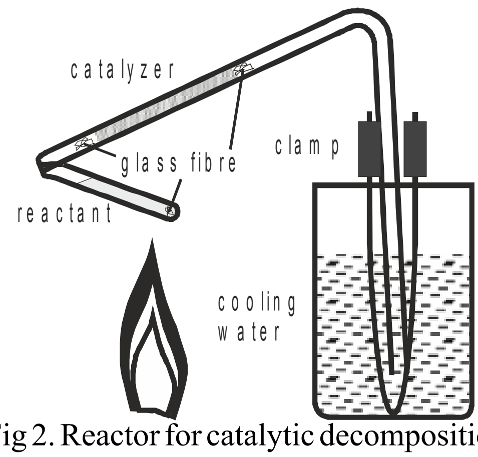

Fig 2. Reactor for catalytic decomposition

Initially students of 10th grade (15-16 y.o.) spent about one hour to make 1-shape reactor, however later the time shrank significantly. There are the following hazards: (a) students burn their fingers with hot glass while blowing (especially for the first time); (b) reactors can be destroyed if they are heated in a not proper way and the reactants can inflame. It is not very dangerous because of the small amount of reactants but quite striking.

THE ESTABLISHMENT OF “MICROSCALE & SEMI-MICROSCALE ORGANIC CHEMISTRY EXPERIMENT” COURSE

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Microscale chemistry has become a worldwide research hotspot nowadays. It is one of the epoch topics in “green chemistry” and “education innovation”. To adopt and popularize microscale chemistry mode in university laboratories is of realistic and profound historical significance for embodying the scientific concept of sustainable development.

Aiming at the abuses brought about by traditional organic chemistry experiment, such as the wasting of much reagent and time, the producing of pollution that harms the health of teachers and students, we has established a “microscale and semi-microscale organic chemistry experiment” course system and teaching mode that are reasonable in scientific orientation after ten years of hard working.

Considering the practical situation in China, our task group has developed “portable microscale chemistry experiment instrument”, compiled and published the teaching book Microscale and Semi-microscale Organic Chemistry Experiment (Higher Education Press, 2003), completed the multimedia courseware and teaching video for Microscale and Semi-microscale Organic Chemistry Experiment, made efficient use of internet new technology to form a stereo teaching mode.

Depending on different types and difficulties of experiments, we have respectively adopted microscale, semi-microscale and small-amount operation for ten years of practice and achieved good teaching result. The students were inspired with interest in experiments, the precise and painstaking style of study was cultivated and the experiment operation ability was universally strengthened. This teaching mode was applied to many higher schools in China, creating active effect, and was honorably awarded teaching achievement prizes at national level. Our “portable microscale chemistry experiment instrument” designed has won the national patent (Patent No.ZL00242172.0).

We have combined the microscal reform closely with organic chemistry experiment course to form the unique course system, therefore the microscale and semi-microscale organic chemistry experiment course presided over by me was entitled “National Level Fine Course” by the State Education Ministry in 2007.

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FACTORS AFFECTING JUNIOR SECONDARY SCHOOL STUDENTS' ATTITUDES TOWARDS CHEMISTRY AS A SCHOOL SUBJECT

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The aim of the study was to identify the most significant factors which influence junior secondary school students' in chemistry as a school subject and to attempt to establish correlations between them. Students' attitudes were surveyed using a specially prepared questionnaire. It consisted of items which were to measure students' views on the knowledge about chemistry they are taught during the lessons, its usefulness in daily life, their difficulties in learning chemistry, the teachers and their lessons, the textbook, the studies they are planning to pursue in the future, etc. A Likert scale ranging from 1 (strongly agree) to 4 (strongly disagree) was used. The students were also asked to indicate their level of interest in 12 selected topics taught in chemistry lessons at school.

The questionnaire was administered in April and May 2011 among 1,902 chemistry students in the third grade (approximately 15-16 years old) studying at 38 Polish schools. The school sample was selected based on two criteria: the score obtained by the school in the maths and science part of the external exam and the size of the town where the school is located.

The study showed that the students liked their chemistry teachers and thought their assessment practices were fair, but the lessons themselves were not found interesting. The students would not like to have more chemistry lessons or take part in extracurricular activities related to the subject and their interest in the subject tended to decreased with each lesson. The students did not see the chemistry knowledge acquired in junior secondary school as relevant for their future professional careers. The vast majority declared that they would not choose chemistry for their school leaving exam or pursue studies which would require knowledge in this subject. Moreover, they did not find the textbook helpful in learning chemistry, as it was not interesting and did not help them understand the topics discussed in class. They did, however, appreciate the role which experiments carried out during the lessons played in the learning process. The study also found that a high frequency of in-class experiments correlated with a positive attitude towards chemistry knowledge, the lessons and the teacher. Finally, the topics which the students were the most eager to learn during their chemistry lessons were those directly or indirectly related to their daily lives, whereas balancing chemical equations and chemical calculations were of the least interest to them.

MINIMUM ACHIEVEMENTS IN CHEMISTRY

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A comparison of pupils' achievements between the federal states of Germany showed, that these vary higher than in other PISA-participant countries (PISA, 2004)[1]. German pupils are able to keep up with higher level of education compared to other OECD-countries, but in the lower range of performance they show significant deficits. This is interpreted as an indication for the fact that minimum standards are not established in Germany so far. Therefore Klieme et al. (2007)[2] demand for modeling and definition of minimum standards. The German ministry of education (KMK, 2004)[3] published educational standards for the subjects German, English and Mathematics for lowest-possible graduation. These standards are missing for further subjects until now. According to Ralle (2009)[4] minimum standards have to be specified as skills, which *all pupils have to command at the end of their education at school in order to participate actively in professional and public life and which are necessary to arrange their private life, independent of school types, individual* general requirement and institutional prospects.

The central aim is the exemplary description of minimum standards for chemistry at the age of 15 (grade 9 respectively grade 10).

From a standardized questionnaire created for experts like chemistry teachers (n=30), chemistry educators (n=30) and chemists working in the industry and economy (n=30) their opinions will establish the basis for what they expect as a minimum standard of learning (see table below). Significant trends become visible and furthermore provide a preliminary catalog for the basic minimum requirements in chemistry as a result of the realized pilot study.

The lecture provides information about the measuring instrument as noted above and gives first results of the pilot study, too.

pilot study: *April 2011 till Sept. 2011*	main study: *Oct.2011 till May 2012*
n = 31 (students of chemistry education) within Berlin	n = 3×30 (three groups, see above) within Germany

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JAPAN-KOREA COOPERATIVE LESSON ON THE TOPIC OF BIO-DIESEL IN CHEMICAL EDUCATION: FOCUS ON PROMOTION OF STUDENTS' ABILITIES IN PROPER JUDGMENT

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A lesson model of high school chemistry on the topic of bio-energy is proposed herein. The model is aimed at promoting student's ability to judge social problems about energy supply by knowledge of science. Contents of the lesson are composed of the following, (1) Lecture: "Energy situation and development of bio-energy ", (2) Lecture and Experiment: "Generation of bio-diesel and Comparison of bio-diesel and diesel as a fuel from the standpoint of energy", and (3) Activity: "Evaluation about bio-energy and diesel".

The model was carried out in August 2011 for 21 Japanese students and 19 Korean students of the 11th grade. There was not necessarily significant difference in the academic achievement by TIMSS (Trends in International Mathematics and Science Survey) evaluation; however some findings appeared by the assessment of this cooperative lesson. According to the conducted questionnaires, number of the reasons for an agreement with or opposition to the construction of facilities of energy supply like fossil fuel increased to about 1.5 times per a student after the lesson (Fig.1). On the aspects of the reasons, not only the aspect about ecology but those about science (chemistry) and technology increased after the lesson (Fig.2). Since bio-diesel *vs.* diesel was evaluated as a fuel, various criteria from the standpoints of the cost, responsible concern for the environment, fuel efficiency and so on were raised to the surface. An each grade of both materials as a fuel was determined by the rule to score all the standpoints to it, so that bio-diesel was higher grade. The lesson model realized to promote students' abilities in proper judgment by versatile knowledge including that about science.

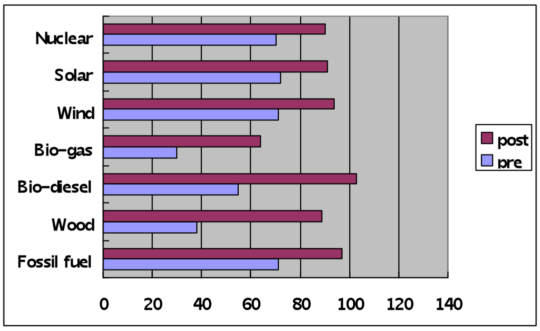

Fig. 1. Number of reasons toward agreement

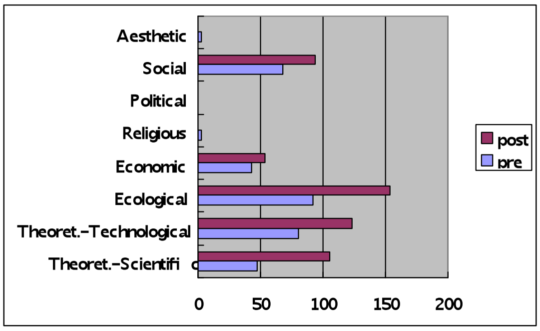

Fig. 2. Number of reasons from the standpoint

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INFORMATION TECHNOLOGIES IN SERVICE OF CHEMISTRY TEACHING (ON AN EXAMPLE OF CONCRETE PROGRAM)

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The article presents author's multi-media teaching course on school course chemistry, created in Ilia State University**.** Teaching materials are presented together with visual dynamic models of chemical processes. The changes and additional information can be introduced any time due to the structure of the course. Therefore, the model contains the elements of Case Study.

Those principles of didactics are considered (1,2), realization of which are particularly efficient by educational computer programs on the lessons of chemistry. The question is about the stages of educational process, during which teacher can efficiently use such programs. In the article is overviewed the situation of teaching chemistry in Georgia nowadays- problems and the ways of solution of this problems. Is shown the ways to integration chemistry with other subjects, e.g. biology, history and arts.

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USE OF SIMULATORS IN THE TEACHING OF CHEMISTRY

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The teaching of chemistry has undergone many changes over time, mainly influenced by scientific discoveries; one of the greatest challenges today is to build new knowledge together with a larger share of the population, increasing access and promoting development. To have a truly inclusive scientific literacy, we must keep in mind that aren't a homogeneous society, respect the potential and promote interaction among the various groups that compose it. This abstract will present the use of a laboratory simulator in teaching experimental chemistry.

With the objective of to increase the reach and construction of new knowledge in chemistry was developed, with high school students and graduation, a simulator laboratory software, that makes use of image capture technology combined with a graphical interface making possible the realization of numerous experiments. It doesn't work alone, because two actors need to be in complete harmony, the student and teacher. On the computer the student develops the activities oriented by the teacher with laboratory glassware, virtual reagents and webcam to design it in the virtual laboratory. The software uses other multimedia resources that can enrich the content of the subject, such as audio, instructional videos and atomic models. The student observes two videos before starting the practice, containing the historical context and examples of the experiment. The teacher has to intervene and encourage students to question what was being presented, because this interaction was the real agent who promoted immersion in the teaching of chemistry.

Figure 1. Image of the simulator.

The project is showing significant results, since its inception in April 2009, as increased understanding and interest in the disciplines and the reduction of accidents in laboratories. On first contact with the tool there is the natural barrier of a new technology and its manipulation, which the young assimilate quickly. The tool proved to be compatible with some expectations of the teaching of chemistry, contributing to the development of themes and having great impact on students and institutions that don't have continuous access to laboratories. The simulator didn't replace the real laboratories, in this process, is an additional resource for teachers and teaching practices.

MULTI-PLAYER GAMING AND THE LEARNING OF CHEMISTRY

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A multi-player game, the Legends of Alkhimia (LoA), and its associated instructional strategies were developed to explore the affordances of immersive and narrative-driven environments[1] that computer games could provide to the learning of chemistry. The game focusses on the inquiry-based learning of Grade 7-8 chemistry concepts such as separation techniques and acid-base reactions. In the game, the students role-play as apprentices of a master chemist to tackle a series of challenges encountered in the various game levels; players will encounter problems in the game world and need to travel back to the in-game virtual laboratory to hypothesize the source of the problems and conduct experiments to generate possible solutions to the problems. They then go back to the game world to determine if the proposed solutions will work. The students are required to act, think and solve problems like a chemist; they learn to be a chemist instead of merely learning about chemistry[2]. Three pilot studies using a six-level version of the game were conducted in two school to determine the students' and teacher's reactions to the game, and understand the issues and challenges of implementing game-based learning in school. Students stated that they enjoyed playing the LoA and valued the opportunities to explore and experiment with the different apparatus and substances in the in-game laboratory. However, it was observed in all three studies that the students were not engaging deeply with the chemistry concepts during experimentation in the in-game laboratory and in the game-world activities. A teacher who was involved in one of the pilot study felt the tension between giving students time to let them work things out for themselves versus guiding them to learn what they are supposed to learn in the minimum time possible. She also voiced her concern that students needed to have the pre-requisite knowledge before playing the game instead of being able to play the game and learn the relevant content supported by the tools in the game and the design of game[3]. As the adoption of game-based pedagogies may require a drastic change in teachers' beliefs of how students learn and should be taught in schools, support needs to be given to teachers by game developers and researchers in the initial stages, and at a later stage, by community of peers who were earlier adopters of game-based learning.

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MEMS DESIGN TOOL IN TEACHING ORIENTATION DEPENDENT DOUBLE SIDED SILICON ETCHING

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Silicon is the most preferred material in Micro-Electro-Mechanical-System (MEMS) industry due to its mechanical properties and thermal conductivity. A large number of micro-machined structures are realized using wet etching of silicon. Potassium hydroxide (KOH) and Tetramethyl ammonium hydroxide (TAMH) are most popular wet anisotropic etchant available in the market.

Many MEMS structures are realized using anisotropic etching of silicon e.g. membrane of pressure sensors. The thickness of silicon wafers are usually 500 µm and if we want to realize the membrane of thickness of 1µm using single sided etching is difficult, because we need a thick layer of SiO_2 for masking to perform the etching successfully but the maximum thickness of SiO2 is limited to 2 µm using thermal oxidation, which is not sufficient as a mask for entire etching process. To overcome from this difficulty, double sided etching of silicon is performed. To perform the double sided etching both masks should be aligned properly misaligned mask may lead to change of membrane dimension. Also in process it passes through many shape changes.

Anisotropic etching of silicon is plane dependent and with the progress of time etch pattern is also changing. Therefore it is very difficult to understand the concept of double sided etching of silicon by students and at the same time it is also very difficult for an instructor to convey the information properly using black board teaching which needs a very good drawing skill as well as a lot of time. To overcome this difficulty IntelliSuite 8.6 computer based MEMS simulation tool can be used, which can capture the etch profile of the structure for different time interval and it also provide the option to make a video file of etching process which can be used for teaching the double sided etching of silicon. Through this paper an attempt is made to explain how effectively ICT can be used in teaching the double sided silicon etching process

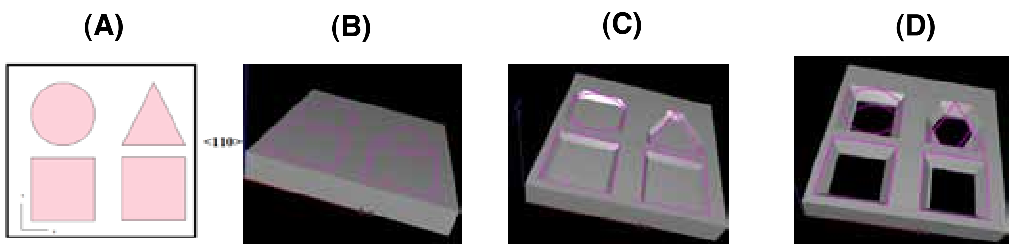

Fig1. (A) Mask pattern along <110> direction; (B) to (D): Progress of etch profile from beginning to end of the etching process.

STUDY ON MOLECULAR STRUCTURE ANALYSIS USING HIGH PERFORMANCE COMPUTING

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A ribonucleic acid (RNA) sequence is made of individual molecules known as nucleic acids, which can be one of four possible types - Adenine (A), Cytosine (C), Guanine (G), and Uracil (U). A RNA sequence folds upon itself to form bonds among its molecules known as base pairs and the overall structure is then referred as its secondary structure.

RNA structure analysis is a computationally complex task. As the sequence size increases the complexity become more to handle. This gives rise to handle the analysis using parallelization technique. Parallelization can be achieved by the way of networked GPGPU based systems.

Parallelism capacities can be exploited in the study of RNA structure in order to minimise the computation speed. Parallelism can be achieved at the critical sections level in the analysis of RNA structure.

Parallelism capabilities can be exploited in the code level as well as in data level. Speed-up gain can be achieved by exploiting the inherent parallelism and also provokes the advantages of using GPGPU based systems towards designing more sophisticated methodologies for handling a fairly long sequence of RNA.

In this paper such methodologies namely code parallelism and data parallelism to deal with the critical section level in the RNA structure is discussed.

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HIGH QUALITY OF MODERN VS TRADITIONAL METHODS IN TEACHING UNIVERSITY STUDENTS

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Traditional education or back-to-basics refers to long-established customs found in schools that society has traditionally deemed appropriate. Depending on the context, the opposite of traditional education may be progressive education, modern education (the education approaches based on developmental psychology), or alternative education (1). Teachers are the instruments by which this knowledge is communicated and these standards of behavior are enforced (2). Our society these days are divided in to two different way of thinking on the education. Some believe that modern methods are better than the traditional method of teaching. The present study describes using power point for presentation the lectures for the students at the Department of Chemistry, College of Education, University of Salahalddin, Erbil, Iraq, which leads to high quality in teaching.

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INFLUENCES OF CONTEXT-ORIENTED LEARNING ON STUDENTS' SITUATIONAL INTEREST AND ACHIEVEMENT IN CHEMISTRY EDUCATION

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Although, context-orientation was implemented in several countries around the world, there is still a comparative lack of research-based evaluation into the effects of their use (Bennett & Holman, 2002). While most evaluation studies show that context-orientation has a positive influence on students' interest and motivation, context-effects on students' learning achievement are less positive and inconsistent (e. g. Osborne & Collins, 2002; Yager & Weld, 1999). Fechner (2009) showed for the chemistry domain that students' learning with real-life contexts outperformed students' learning with subject-related contexts in a situational interest questionnaire as well as in accompanying achievement tests. However, effects vary depending on the implemented context.

The present study attends to the effects of context-oriented learning on students' situational interest and achievement concerning different areas of content knowledge in chemistry. The study was conducted with 176 9th graders from higher track secondary schools. With regard to their prior knowledge, students' were assigned to one of two context-groups – a real-life context group (lakes) and a subject-related context group (laboratory). Each group was asked to learn the different chemistry contents embedded in the respective context. Thereby, worked-examples served as learning materials. Effects of the study were measured in a controlled pre-, post and follow-up design by the use of paper-pencil tests. Results show a main effect of context-oriented learning on students' situational interest ($F(2,153) = 5.95$; $p = .003$; *partial* $\eta^2 = .072$) as well as on students' perceived relevance ($F(2,153) = 10.50$; $p < .001$; *partial* $\eta^2 = .121$). Thereby, effects vary depending on the respective chemistry content-knowledge to acquire.

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HOW DOES THE QUALITY OF CONTENT-RELATED COMMUNICATION INFLUENCE THE LEARNING OUTCOME IN SMALL-GROUPS?

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Scientific Topic: *Communicating Chemistry - Teaching and learning Science and Chemistry*

This study deals with the communication in small-groups in order to investigate possibilities to increase the quality and amount of content-related statements. The aim of the study is to investigate the relation between the quality of students' content-related statements and the learning outcome. For this purpose, existing video data of a preceding research project on experimental inquiry tasks in chemistry education (Walpuski, Wahser, & Sumfleth, 2008) were reanalysed to describe the communication characteristics of successful and less successful small-groups. In this context, success refers to the learning outcome of the small-groups. Therefore a category system to analyse the quality of content-related statements was developed. To test the developed category system 30 videos of 15 successful groups and of 15 less successful groups were reanalysed using the program videograph®. By means of the category system, correlations between specific communication characteristics and the learning achievement can be ascertained. Due to the fact that these correlative relations do not reveal any causal direction an additional intervention study was conducted, to investigate if an optimisation of the communication quality also leads to a higher learning achievement. For this purpose, the instructions of the small-group work were revised on basis of the reanalysis in order to foster communication from a subject-specific viewpoint. The topic of the small-group work was acids and bases. The intervention study lasted five lessons in the 7^{th} grade of 12 German secondary schools (high-level). Data was collected of a sample of 192 students in total. The control- and the intervention group were balanced on basis of the cognitive skills (Heller & Perleth, 2000) and previous knowledge. The learning effectiveness of the revised instructions was examined by use of subject-specific achievement tests. Shifting in communication processes were observed by conducting a category-based video analysis. By means of the analysis of 240 videos of the small-group work and the tests on content knowledge it could be shown that the revised instructions lead to a higher rate of high quality content-related statements in fact. On account of this, it could be shown that an increase of the quality of content-related statements also leads to a higher learning achievement.

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SOME NON-STANDARD WAYS OF DEVELOPING AND ASSESSING DEEP UNDERSTANDINGS, OF CHEMISTRY STUDENTS

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Research in science education has exposed a myriad of misconceptions among students, many of them common across geographical regions and levels of education. Some of these non-scientific ways of thinking (misconceptions, students' conceptions, or alternative conceptions) are found even in students who score highly in standard assessments and in international science studies.

The findings have led to the 'constructivist' movement, at the heart of which is the premise that students' understandings are constructed from deliberate and active attempts to reconcile prior knowledge and new information, rather than by transfer of knowledge from teacher to student. A corollary of this is that if we teachers give experiences that help students to construct useful and meaningful knowledge that is consistent with the beliefs of the scientific community, we need to know something about the prior understandings of the students.

In this workshop, participants will be introduced to a variety of ways that can help us to show where our students are really 'at', and opportunities will be provided for the participants to develop examples suited to their contexts. Approximately 50% of the workshop will be devoted to probing understandings through diagnostic two-tier test items.

In addition, we will explore some types of 'thinking tasks' that can be labelled as follows:

- **concept mapping**
- **Venn (relational) diagrams**
- drawing mental images
- predict-observe-explain (POE) about situations
- interviews about instances and events
- inserting sub-headings in text
- interpreting diagrams
- linking examples and evidence to principles
- matching reasons and instructions
- sorting out scrambled calculations
- sorting out scrambled instructions
- reversing the task
- what data is necessary?
- the calculation is wrong: where, and why?

It will be evident that most of these methods can be used for quality teaching, as well as for exploring understandings.

'ORGANIC CHEMISTRY IN ACTION!' – A TRIALLED INTERVENTION

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Organic Chemistry in Action! is a research-based resource designed to facilitate the teaching and learning of Second Level and Introductory Third Level Organic Chemistry. Organic formulae [1], curved arrow diagrams [2, 3], mechanisms [4], and laboratory classes [5], have all been identified as difficult topics. The main areas of difficulty in Leaving Certificate Organic Chemistry in Ireland were firstly identified [6]. These findings were supported by previous Irish studies [7, 8]. Using these findings and those from Chemistry Education Research, the intervention progamme was developed. The intervention materials were designed with specific reference to the current Irish Leaving Certificate syllabus [9]. The materials can be used with introductory third level Organic Chemistry and the proposed new Leaving Certificate syllabus [10].

The teaching materials were developed using specific design criteria: spiralling of topic development, linking outcomes & assessment, facilitation of cognitive development, inquiry learning, visual aids, integration of contextual applications, integration of practical work and early identification of misconceptions. A variety of teaching approaches were employed throughout the intervention programme. The materials were trialled in nine second level schools. Feedback from the participants as well as comparisons with eight control groups using the traditional approach, were used to evaluate the intervention. These results will be discussed in the conference presentation.

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THE EFFECT OF USING COOPERATIVE LEARNING ON STUDENTS` ACHIEVEMENT IN ORGANIC CHEMISTRY: (WITH SPECIAL REFERENCE TO HARAMAYA UNIVERSITY FIRST YEAR CHEMISTRY DEPARTMENT STUDENTS)

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The purpose of this research was to investigate the effect of cooperative learning on achievements of first year chemistry students' learning outcomes in organic chemistry in Haramaya University. In this study, 14 females and 91 males (totally 105) students were participated. Since, the nature of this research is experimental; the sample students were randomly divided into experimental (51 students) and control (54 students) groups based on their section. To suit to the purpose, the subjects in both the treatment and control groups were exposed to the same study unit that actually covered during organic chemistry I. For the former group the contents of the unit were treated with an approach (cooperative learning), while for the later, the same was dealt with following the traditional lecture method approach. To measure differences between experimental and control group, identical pre-test, quiz, assignment, and post-test evaluations were administered simultaneously. The results obtained indicated that, there was no significant difference in the pre-test and assignment achievement scores of students between the experimental and control groups, whereas, statistically significant difference was observed between experimental and control groups with the two sample t-tests (at $p<0.05$) taken on the quiz and post-test achievement scores of students. The experimental group students were found to be more benefited than those in the control group. The responses to the questionnaires gathered from the experimental group have indicated that cooperative learning was effective in acquiring Chemistry concepts during working together with in their group. This is also supported by experimental group students' positive attitude observed on some interviews made regarding the effectiveness of cooperative learning experiences in organic chemistry class.

Key words: cooperative learning, lecture method, experimental group, control group

FAILING STUDENTS IN GENERAL CHEMISTRY COURSE: A FRAMEWORK FOR THEIR REASONS

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Students' performances are evaluated throughout their education process either by schools or by national/international examination boards. Therefore, students experience the feeling of failure or success during this process; they attribute the reasons behind their performances to varying factors. Although, students' attributions about their academic achievement have been studied widely for last forty years (Holschuh, Nist, & Olejnik, 2001; Beyer, 1998; McAuley, Duncan, & Russell, 1992), studies on academic failure in higher education still have potential to take attention. For that reason, this study investigates the reasons of failure in General Chemistry course designed for engineering students. The sample was selected purposively through case sampling methods. The participants were ten students from varying engineering department who have failed the chemistry course at least three times. Semi-structured interviews were conducted with students to reveal their reasons for failure. Based on the responses, themes and codes are formed to draw a framework (analysis of the data is going on). The implications and limitations will be discussed later when the analysis of data have completed.

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STUDENTS' ACHIEVEMENT ON CHEMICAL REACTIONS AND ENERGY CONCEPTS THROUGH CONTEXT-BASED APPROACH

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The last two decades have witnessed many curricular activities in chemistry education field which mainly centers the attention on usage of real-world contexts through contextual teaching. Therefore, a renewed interest has emerged to investigate why to use/ how to use/ and the effect of a real world contextualized instruction (Barker & Millar, 1999; Belt, Leisvik, Hyde & Overton, 2005; Bennett, & Lubben, 2006; Bulte, Westbroek, De Jong & Pilot, 2006). Therefore this study aimed to investigate the effect of context-based instruction (CBI) over traditional instruction on eleventh grade high school students' achievement on chemical reactions and energy subjects. Two 11^{th} grade classes totally with 61 students taught by the same teacher from a public high school of Ankara in 2011-2012 fall semester were enrolled in this particular study. The teacher had an experimental group and a control group. These classes were assigned randomly as experimental and control group. The students in experimental group took an instruction designed according to context-based approach in which a real life context is covered throughout the chapter whereas students in control groups were instructed with traditionally designed chemistry instruction. Chemical reactions and energy concept test was administered as a pre-test to both experimental group and control group to investigate preconceptions of students prior to implementation. Achievement test on chemical reactions and energy was administered as a post test to both groups; for the analysis of quantitative data, the t-test was used to check whether means of two groups were statistically significant or not. The results of the study revealed that CBI was superior to traditional instruction on students' achievement in the chemical reactions and energy concepts.

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TEACHING POINT GROUPS USING MODULAR ORIGAMI

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Symmetry is an essential concept for chemistry and during their education future chemists learn about molecular and crystal symmetry.[1,2] This is usually limited to basic geometrical aspects of symmetry and "mechanical" usage of tables (*e.g.* character tables, diagrams for determination of point groups). Consequently, the knowledge about symmetry mostly remains on the intuitive, mathematically superficial, level, with little or no understanding what terms like "character", "point group", *etc.*, really mean. Although this is often sufficient, a deeper mathematical knowledge of the matter can support thorough understanding of chemical topics. The drawback is that teaching group theory and other abstract notions requires a significant amount of time, and the usual teaching materials are written in a technical style that is hard to read and understand. Polyhedra models have been used for a long time in teaching symmetry and point groups. Such cardboard models have the disadvantage that they are easily destroyed, and their construction can be untidy and time-consuming. Modular origami is a technique of making paper models from several units folded from rectangular paper sheets and assembled into the final model, without gluing, so the model is easily dis- and reassembled. These models are usually developed from an aesthetic viewpoint, and mostly have cubic and icosahedral point groups.[3,4,5] This presentation shall present a systematic, at the same time visual and mathematically sound, approach to using modular origami polyhedra for teaching point groups using a inquiry-based hands-on approach.

Figure 1. A regular triangular prism and (a model of) a $SbCl_5$ molecule have the same point group (D_{3h}) symmetry.

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PREDICTING SUCCESS OF FRESHMEN IN CHEMISTRY

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In academic chemistry courses, student success is frequently noticed to be rather low. Only about 70 % of freshmen succeed in the beginners' course in general chemistry.[1] Likewise, in dropout rates this low student success can be observed since 31 % of German chemistry students end up their studies before the scheduled time.[2] A lot of approaches have been done to determine factors that lead to success in chemistry. This study aims at investigating those factors, too, but also wants to deepen the knowledge about these so called predictors by seeking for interactions between them and at the same time combining performance and motivation related variables.

A pilot study on freshmen was conducted at Duisburg-Essen University in Germany at the very beginning of winter semester 2010/11. Chemistry majors (N = 90) and Chemistry education students (students in the university teacher education program, N = 75) were asked to give information on a variety of variables; those who emerged to be meaningful for regression are shown in Table 1. All analyses were conducted for all students and, in addition, separately for majors and education students, respectively. For the prediction of the score in the final exam at the end of first semester, all variables were added to three linear regression models in a blockwise manner in the order given in the table. Only for majors, desired subject ("*Would you rather prefer to study a different subject?*") significantly accounts for score in the final exam. Subsequent moderation analyses revealed several interactions between the predictors that differ strongly between majors and education students. For example, concerning prediction of score in the final exam by cognitive abilities (only majors) and subject interest (only education students), there is a difference for students who study their desired subject and those who do not.

Table 1. Results from regression analyses.

	All students	Majors	Educ. students
1 Pre-knowledge	$p < .001$	$p < .001$	$p < .05$
2 Cognitive abilities	$p < .05$	$p < .1$	$p < .01$
3 Desired subject	$p > .1$	$p < .05$	$p > .1$
4 Subject interest	$p < .05$	$p < .1$	$p < .1$
Explained variance	23.5 %	33.0 %	20.6 %

The survey has already been repeated at four universities in Germany in winter semester 2011/12. Data analysis has not been finished yet. From the data, the relation between students' pre-conditions and score in the final exam can be further elicited which helps understanding where student success comes from and how it can be adequately enhanced.

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HISTORY, POLITICS, CULTURE: NSF & THE SCIENCE EDUCATION WARS SINCE SPUTNIK

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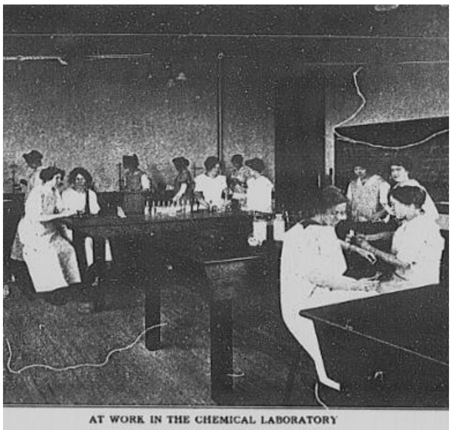
Science Education Reform is a popular topic in schools and universities, in the press, and in a myriad of continuous online conversations. For faculty and teachers who have been around "a few years" and who pay attention to such things, many of the discussions (and the reform efforts undertaken) can seem rather familiar. Are any of the currently popular ideas really new, or have they been around for decades, or even centuries? Is "Active Learning" better than…the opposite? What has changed in 50 or 100 years? Are there significant differences in the histories of science education reform among countries?



AT WORK IN THE CHEMICAL LABORATORY

This presentation focuses mainly on the historical role of university science faculty and the US National Science Foundation in science education reform in higher education. The timeline is from the 1950s through the present in the USA, but the discussion is grounded in philosophical positions and events stretching back into the 1800s and across continents. A journey through key events and the characters on the "stage" may give us a basis for understanding our thinking today, if not a prescription for change. Highlights include the role of psychologist William James, the 1893 Committee of Ten, John Dewey and the Progressive Education Movement of the 1920s-40s, the 1959 Woods Hole meeting of scientists convened by Jerome Bruner (with the legacy of CHEM Study, PSSC physics, and MACOS from the NSF funding of the 1960s), and the NSF Chemical Education Systemic Reform initiatives of the 1990s.

Is there a prescription that research can find for "what works" in science education? Our individual and collective philosophies and cultures collide around our differing assumptions about the purpose of education. Who can (or will) arbitrate the Culture Wars?

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CHEMICAL PRINCIPLES VISUALIZED: INTERMOLECULAR FORCES

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Videos and animations, while helpful in visualizing chemical principles, do not stimulate students as much as live demonstrations and hands-on in–lecture-room activities. Chemistry classes should include some active participation and should not be “chalk talks”. Demonstrations/activities can be as simple as passing element samples around the lecture hall, but should not be too complex. Active demonstrations should be easy to set-up, safe, and should focus on specific chemical principles. This presentation will use demonstrations and hands-on activities, accompanied by some animations, that can be used in classes for visualizing intermolecular forces such as dispersion forces. dipole-induced dipole, ion-induced dipole, hydrogen bonding, and salting effects.

POSTER

TUESDAY 17 TH
POSTER SESSION 1

IDENTIFICATION OF PRE-SERVICE SCIENCE TEACHERS' MISCONCEPTIONS ABOUT SOME CHEMISTRY CONCEPTS BY TWO-TIER DIAGNOSTIC TEST

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During the last few years, researchers have begun to focus on the factors that affect students' understanding of scientific conceptions. According to Bodner [1, 2] the most important factor that affects learning is the student's existing conceptions. For this reason, science educators have developed some methods to identify misconceptions. Two-tier test, a pencil and paper test in a multiple-choice format, has been proposed by science educators to diagnose misconceptions [3, 4].

This study was conducted to identify pre-service science teachers' misconceptions about the subjects of *"Mixtures, Physical and Chemical Changes, Acids and Bases"*. For this purpose, a two-tier diagnostic test consisting twenty three items related to these aforementioned concepts was developed by the researchers by considering misconceptions identified in the literature. Both the first and second tier of the test presents multiple choice items. After pre-service teachers make a choice in the first-tier, they explain their choice in the second tier. In this way, while their initial preconception is determined at the first step, the reason of their choice is investigated at the second step. The test was validated by a group of chemistry educator, and then applied on 102 undergraduate students and the reliability coefficient (KR-20) was found to be 0.72.

This test applied to first, second, third and fourth year pre-service science teachers, in an education faculty in Istanbul. The results showed that pre-service science teachers had many misconceptions related to acids and bases in the daily life, indicators, neutralization, strength of acids and bases, properties of acids and bases, pH, solutions, solubility, physical and chemical changes.

Achievement in Science and Chemistry education depends upon levels of teachers' quality and inaccurate. Teachers who have misconception forward tell these misconceptions to their students. For these reasons, diagnosing pre-service teachers' misconceptions is important and makes a major contribution to teacher education by like this study.

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STUDENT'S MENTAL MODELS FOR MATERIALS AND CHEMICAL SUBSTANCES

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The aim of this study was to reveal the mental models that students use in order to recognize materials and chemical substances, as well as to investigate the influence of teaching on these models. Mental models are dynamic and generative representations which have been created to provide causal explanations and make predictions about physical phenomena and help to integrate new information in cognitive system1. Students hold a variety of conceptions about subjects, material and substances when developing the concept of "matter"[2,3.] These conceptions are expressions of students' mental models summarized as "commonsense chemistry"[4] and our study focuses on their progression upon chemistry teaching.

Seven questions were used to elicit the students' conceptions about the materials in order to reveal students' mental models. Students of 7th-grade (N=107) and 9th-grade (N=114) answered the questionnaire. The constant comparative method of qualitative analysis[5] was used resulting in two groups of criteria used by students in their answer: (a) *the characteristics of observation*, (shape, size, smell and colour) and (b) *the changes of material/substance or their interactions with other materials/substances* (magnetization, rusting, and burning). Based on students' consistency in using these criteria three mental models were resulted: the *sensory*, the *interaction model*, and the *mixed* one. The students' percentage that used the sensory model is reduced from 7th-grade to 9th-grade whereas the students' percentage that used the interaction model is increased. It is obvious, that the students change their initial sensory models to synthetic ones as a consequence of teaching and the characteristics of observation are replaced by those of change or interaction step by step.

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RELEVANT AND POPULAR LESSONS AND SCIENTIFIC LITERACY: APPLICATION OF MODULES FROM THE EUROPEAN PROJECT PARSEL

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PARSEL stands for *Popularity And Relevance of Science Education for scientific Literacy*, and is a European project, which has produced educational materials that are available, in English and in a number of other European languages, free of charge on the Internet, at: http://www.parsel.uni-kiel.de/cms/. They aim to promote scientific literacy and to enhance popularity and relevance of science teaching and learning (OECD-PISA, 2005). The materials cover a range of student levels (Grade 7 upwards) and science subjects. Each module is structured into five sections: purpose; student activities; teaching guide; assessment strategies, and teacher notes. In the present study, we present the results of the application of the following four modules 1) Growing plants: does the soil matter? (2) Milk: keep refrigerated; (3) Popcorn, a fat-free snack; (4) Should vegetable oil be used as fuel? (Biodiesel).

Method. 38 senior high school students in a semi-urban area in the south of Corfu Island, Greece, participated in the study. They answered a questionnaire in the form of semantic differential scale, which originated in the application of PARSEL modules in Israel. The questionnaire was administered to the students twice, once before the application, and a second time after the application (test-retest method).

Results. We detected very large differences of the values for after the application of the PARSEL modules in comparison with the case before the application. In all cases, the superiority of the positive opinions was overwhelming after the application, while there was no substantial difference between the negative and the neutral opinions. The 20 questions were categorized under four dimensions: (a) *Cognitive domain* (learning), (b) Affective domain (satisfaction), (c) Relevance to students' life, and (d) Teaching approach. The statistical data showed that the cognitive domain and the relevance led the way, with the teaching methodology following and the affective domain being last.

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COMPARATIVE EVALUATION OF JUNIOR HIGH-SCHOOL CHEMISTRY TEXTBOOKS: THE ROLE OF SCIENCE EDUCATION

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A book that entitled "Introduction to physical science" (physics and chemistry) for the 7th Grade" has been written by researchers in science education (the first and the third author) for the seventh grade (first grade of lower secondary school) in Greece, on the basis of principles of science education (Tsaparlis and Kampourakis, 2000). In this paper, we compare the performance in a relevant test of an experimental group (EG) of students who were taught the topic of the 'chemical reaction' from the above book (experimental book, EB) with the performance in the same test of a control group (CG) of students who were taught the same topic from the school book (SB).

Method. The sample consisted of 115 students from six normal urban school classes from two schools. In each school, the class chemistry teacher taught the lesson on chemical reactions from the EB to an intact school class (EG); the same teacher taught the same topics from the SB to a different intact class of the same school (CG). The EG and CG were about equivalent. After the teaching, the students were given the same test for the same period of time (about 20 minutes). The Cronbach's alpha coefficient. values were 0.752 for the EG, 0.690 for the CG, and 0.741 for the total student sample. Three experienced teachers each marked 18 randomly selected papers. The non-parametric *Spearman* rho correlation coefficient gave values ranging from 0.805 to 0.994.

Results. It was found that the EB approaches better the concept of chemical reaction and the conversion of energy (heat changes) accompanying the reactions (1st question). In the case of the 2nd and the 3rd questions the superiority of the EB is at the 10% level. In the case of the 4th question the difference is not significantly different even at the 10% level. In the totality of the four questions, the difference is statistically significant at the 1% level in favor of the EG.

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TRANSLATION OF GAS LOWS REPRESENTATIONS

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The purpose of this study was to investigate students' ability to make translation between initial and target representations[1] of gas lows. Two types of representations were used: descriptive and depictive[2]. In order to answer the question how different descriptive representations influence translation for different gas lows, relationships between three categorical variables were investigated. Categorical variables were: (1) gas low type, (2) initial descriptive representation form and (3) frequency of correct and incorrect answers, i.e. responses. Translation tests consisted from two different forms of initial representations: 1. short form (gas low formula and the explanation of symbols used) and 2. long form (definition of gas low with formula) and two multiple-choice items. In the first item, requirement was to translate the initial representation to target descriptive representation, while in the second item, subjects were asked to translate initial representation into targeted depictive representation. The tests were performed by freshmen chemistry students at the University of Belgrade. Log-linear analysis has shown that the distribution of correct and incorrect answers, for both items, can be explained by joint- independence model in which only one two-way interaction is present: gas low – response. The likelihood ratio test statistic for first item is 15,886, $N= 133$, $df=2$, $p<0,001$ and for second is 7,792, $N=135$, $df=2$, $p<0,05$. The results obtained show that the given gas low definition did not influence translation of descriptive representation to target descriptive one (the first item) as well as into depictive (the second item). The existence of two-way interaction indicates that distribution of correct and incorrect responses in both items depends on the gas low type. For Charles and Gay-Lussac lows number of correct and incorrect answers is approximately the same, but for Boyle-Mariotte low they are quite different.

This research was supported by the Ministry for Education and Science of the Republic of Serbia (Project No. 179048).

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HOW TO IMPROVE LEARNING CHEMISTRY THROUGH PRACTICAL WORK?

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Learning is effective when the optimal balance between what the student knows and what he needs to learn is achieved. The cognitive load theory (CLT)1, a theory of teaching, can help teachers in planning how their students to achieve "optimal balance". The key premise of the theory is that teaching should be based on our knowledge of cognitive architecture. The theory explains how working and long-term memory, cognitive schemas, element interactivity, intrinsic and extraneous cognitive loads influence learning. We are interested in applying CLT, in context of teaching chemistry, in order to improve practical work. Although teachers often use practical work in science education, numerous studies did not show direct relationship between practical work and effective learning.2 Many researchers argue that practical work is ineffective because of teachers' mistakes3. Inefficiency of practical work can be explained by working and long-term memory. Lack of prior knowledge in long-term memory, which is required for understanding the new chemical phenomena in experiments, and the large amount of information that cannot be processed in working memory because of its limited capacity4. Inefficiency of practical work might be result of the fact that teachers often plan experiments for only one class. This approach often does not take in to consideration student's prior knowledge and new information that has to be learned. For students to learn effectively through practical work, teachers need to plan out experiments for whole curriculum in order to achieve the planned educational objectives. Classic didactic understanding of comprehensive educational planning does not require consideration of practical work in this way, which can be the key reason for its inefficient use in practice. Guidelines derived from cognitive load theory can help teachers in comprehensive planning.

This research was supported by the Ministry for Education and Science of the Republic of Serbia (Project No. 179048).

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REAPPEARANCE OF THE NATURE-STUDY'S PHILOSOPHY IN CONTEMPORARY CHEMISTRY EDUCATION IN KOREA

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In this study, we attempt to examine the recent efforts of STEAM in new chemistry education and what needs to be taken into account to make the approach more successful related to the Nature-Study in Korea.

The results of PISA 2006 showed that Korean students perform above average on the understandings of science concepts and yet, showed notably low levels of self-efficacy and interests in science. There was the revision of the national curriculum in Korea in 2009 considering these results. According to the revised national curriculum 2009, one of the key issues is to focus on creativity and character education in science education. These approaches have been incorporated in teaching and learning chemistry in Korea. In particular, the idea of STEM/STEAM (Science, Technology, Engineering, Arts, Mathematics) is strongly emphasized to develop creativity and character education in chemistry education. However, there are anxieties with implementation of this revised curriculum. Recently, a lot of researches have been conducted in the area of STEAM such as innovative classes with STEAM approach, seminars and conferences for STEAM, etc. And yet, those efforts seem insufficient to bring out the ideas of STEAM. One assumption can be made to explain the unsatisfactory outcome, that is, it might be due to the lack of philosophy in this new approach. In Nature-Study, we could find the ideological origins of science education from the object teaching of Comenius in the Europe, which can support the philosophy of science. Object teaching led to common things by Dawes and Mosley. Pestalozzi also inspired the development of object lessons as an educational innovation. The Nature-Study came to the fore in America in the late 19th century. The Nature-Study fell under the influence of the Oswego movement which was a major movement by Sheldon in America based on the idea of Pestalozzi.

The idea of the Nature-Study was introduced to school education in America by the disciples of Agassiz in the late 19th and early 20th centuries.

The objective of the Nature-Study is to put pupils in a sympathetic attitude toward nature. The Nature-Study is a spirit and an attitude of mind and thus is concerned of pupil's worldview. Pupils encounter an ordinary environment by direct observation. They will think for themselves and maintain an individual relation to his world with the Nature-Study. Therefore, the spirit of the Nature-Study can be the direction for development and utilization of the STEAM. As well as, idea of the Nature-Study will be the philosophy in the new approach of chemistry education in Korea.

INVESTIGATION OF HIGH SCHOOL STUDENTS' COMPETENCE IN TRANSLATING BETWEEN DIFFERENT TYPES OF CHEMICAL REPRESENTATION

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Meaningful understanding in chemistry, among others, includes the ability of an individual to think simultaneously at macroscopic, submicroscopic and symbolic level, and this presupposes the competence to translate between different types of chemical representations[1,2.] This competence is an information processing task, requiring understanding of the underlying concept to the extent that the individual can interpret the information provided by an initial representation and infer the details required to construct the target representation[3]. In this study we investigated 11th Grade Greek students' ability to translate a chemical representation into another type concerning various chemical concepts, such as chemical element, chemical compound, solid physical state of matter, aqueous solution and chemical reaction, which have already been taught in earlier grades.

Students' performance (N=466) was measured by an instrument consisting of 10 multiple choice and one open-ended questions, which included real pictures (macroscopic), molecular types (symbolic) and submicroscopic diagrams. Various representations of the three types were given to students and they were asked to choose or to construct an equivalent one of different type. Our results show that students' capacity to move across the three levels of chemistry is very low. Students had lower performance in translations concerning the concepts chemical compound, aqueous solution and chemical reaction compared with those related with chemical element and solid state of matter. They also had the lowest level of performance in translating the submicroscopic representations into the symbolic ones. Although the majority of students were able to translate a submicroscopic representation into an equivalent macroscopic one, only half of them could achieve the reverse translation. Generally, our results indicate that translating between different types of chemical representations is a very demanding task and requires both conceptual knowledge and translating skills.

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CHEMISTRY TEACHERS' VIEWS ON THE CONSTRUCTION OF KNOWLEDGE

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The process of understanding something is similar in many respects in students as well as teachers. In our introductory as well as advanced courses in chemistry at Stockholm University, students try to understand the theories of chemistry, by different methods: memorizing, constructing ideas within themselves, becoming knowledgeable with different practical parts of chemistry, etc. One large problem for the successful use of the teacher is the un-ability or unwillingness of students and teachers to communicate. Lectures would sometime be better of at a rather much slower pace and a significant reduction of the material. Time and again we rediscover why not to overload students. A very common conclusion is that it is better to make some sections of the course properly, compared to extrude the maximum amount of stuff through the students minds.

This presentation will show some results from an investigation on the different views of science (chemistry) among teachers and students as well as ideas of what one of these groups believes about the views of science for the other group.

WHAT IS THE ROLE OF "TEACHING" IN TEACHING CHEMISTRY IN HIGH SCHOOL?

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The question may seem like nonsense at a first sight, but a deeper look reveals that is poses an important issue that has been neglected at the core of some current discussions that have mainly arisen since the notion of the teacher-researcher gained space in the scenery of Science Education back in the nineties.

If it is clearly agreed that teaching Chemistry should go far beyond a mere transmission of knowledge and a dumb submission to a preordered script, as it is so common in traditional school laboratory activities, for example, the notion that "the traditional descriptions of both teachers and researchers change. Teacher-researchers raise questions about what they think and observe about their teaching and their students' learning. They collect student work in order to evaluate performance, but they also see student work as data to analyze in order to examine the teaching and learning that produced it" (1) is quite welcome. However, how far are the activities of teaching, meaning not only but also the choice of appropriate tools, methods, techniques, contents and language to be regarded as of minor importance when compared with the so-acclaimed virtues of a generic scientific research?

Assuming that research on teacher´s work turns out to be of fundamental importance so as to overcome a restrictive view of teaching as the mere transmission of knowledge, but that the nature of research is not absolute, as long as it possesses different aims, practices and conceptions, it is absolutely necessary to define what kind of research is being referred to when addressing a teacher-researcher activity, regarding who, in what circumstance and for what purposes such research is carried out, so as to avoid misconceptions and risks.

An example is a sort of scientific research that overwhelms teaching activities, a belief that has inspired a direct transposition of ordinary scientific routine into school classrooms, as a means of counteracting poor scientific formation of students, as if no differences between school knowledge and scientific knowledge existed at all. This is particularly serious where both the formation of teachers of Chemistry and that of Chemists share the same institution, as it is in Universidade Federal do Rio de Janeiro, Brazil. A more privileged social and academic rank occupied by Science and scientist account for a sort of deformation that privileges research to teaching, something that has important reflexes on the mentality of graduates.

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HOW DO STUDENTS LEARN TO USE REPRESENTATIONS IN CHEMISTRY?

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In chemistry, molecular level processes must, by necessity, be depicted using representations that "stand in" for the atoms and molecules themselves. Students must learn to use these representations with facility, otherwise they are doomed to memorize and regurgitate, rather than synthesize and use their knowledge in new situations. Nowhere is this more true than organic chemistry, but the development of this ability begins in introductory chemistry.

We have investigated the development of these skills beginning in introductory chemistry courses, through organic chemistry, and on to the graduate level. We have used a range of methods, including interviews, surveys, and BeSocratic - a teaching, learning and research system that allows students to draw freehand structures, graphs and simple diagrams. BeSocratic can identify what the students have drawn, determine if the representation is correct and provide contextual feedback for students with varying degrees of specificity. This presentation will focus on the problems we have observed, and present some potential alternatives to current methods of instruction.

A STUDY OF THE RELATIONSHIP OF STUDENT-TEACHER DIALOGICAL INTERACTIONS IN A BRAZILIAN SCHOOL FROM THE PERSPECTIVE OF TOULMIN'S ARGUMENTATION FRAMEWORK, CYCLIC ARGUMENTATION, AND INDICATORS OF SCIENTIFIC LITERACY

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Argumentation has been widely used in the teaching and learning process for the construction of concepts and development of students' reasoning skills[1]. This research has the main objective present the results of how the student-teacher dialogical interactions contributed to the development of the arguments of 25 students from the 10th grade of a Brazilian school, in a investigative laboratory work to solve a problem related to the following question: "Where does the energy come from in chemical changes?"

This study shows the results of the first of six meetings of 50 minutes each, whose arguments were divided into 10 episodes. The classes were video-audio recorded and the arguments identifyed in the transcriptions were analyzed according to Toulmin's Argumentation Pattern[2]. It was also analized the levels of students' argumentative reasoning related to the teacher dialogical interactions, as well as the presence of the Indicators of Scientific Literacy (ISL)[3]. Some of the results are presented on the following table 1:

Table 1: Relationship of student-teacher dialogical interactions from the perspective of Toulmin's argumentation framework, cyclic argumentation, and indicators of scientific literacy			
Episode	Presence of Toulmin's Elements	Teacher Dialogical Interactions	Levels of students' argumentative reasoning
1	D,W,B,C	TDI 1: The teacher accepts what the student speaks, asks examples, and information about the question asked, but does not propose new situations that stimulate reflection. TDI 3: The teacher resumes previous ideas, but directs it to the way you want, anticipating some conclusions.	Level 1: The student interacts expressing views based on stored data. Expressed demands to recall or remember.
8	D,W,B,Q,C	TDI 1: The teacher accepts what the student speaks, asks examples, and information about the question asked, but does not propose new situations that stimulate reflection. TDI 5: The teacher accepts the student speaks, answers the questions, and encourages them to think and use the ideas explained by the students for further reflection.	Level 4: The student estabilishes conceptual conections, and proposes hypothesis in order to solve a problem.

The results indicated that the type of question asked by the teacher affects directly the students' answers and the intensification of the presence of the Indicators of Scientific Literacy, evidencing a cyclic argumentation to solve the main question of the problem, which was resumed by the teacher several times, always in a deeper way. The quantification of the Toulmin's elements may be related to the presence of ISL and to the level of students's argumentative reasoning. The teacher dialogical interactions ranged from TDI 1 to TDI 5.

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NON-SCIENCE MAJOR UNDERGRADUATE STUDENTS' UNDERSTANDINGS OF CHEMICAL FOOD ADDITIVES

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Food chemistry were involved for chemical substances important in food. Nowadays, there has been a great increase in the use of chemical food additives worldwide; however, investigation relevant issues in chemical education were few. We do concern for the quality of the food supply, mainly food adulteration and contamination issues, for example, food colorings agent - sodium nitrate processed in meat, Blue1 used to color candies. These chemical food additives were existed everywhere around us, unavoidable touched in our daily life, easily taken into body and have linked to various health risks. Therefore, we need to pay more attention on the safety of the food intentional contamination. Not only toxic melamine illegally added to baby milk in China in 2008, but also toxic plasticizers contamination of food in Taiwan in 2011; these deliberated scandal issues on food adulteration extremely aroused peoples' concerned with food safety when they purchased commodities. Most of citizens were aware cloudy agent with plasticizers DEHP illegally used and harmful to human health; moreover, they changed their consumption habits. For this reason, investigate students' understandings on chemical food additives and these food scandals were significant important for teaching and learning in chemical education, and may have a great meanings in the social context of these areas as well as in other countries. In this study, non-science major undergraduate students were probed and we found that their conceptions of chemical food additives were poor and incomplete, expect for government regulation; furthermore, they got the information of food contaminating and health risks almost from TV, internet, news paper. Thus, we should pay lots of attentions both on chemical literacy and on media literacy in order to improve their understandings on the emergent field--chemical food additives in chemical education.

Key words: chemical food additives, chemical education, non-science major, higher education

SCIENTIFIC LITERACY: FUTURE CHEMISTRY TEACHERS' CONCEPTIONS

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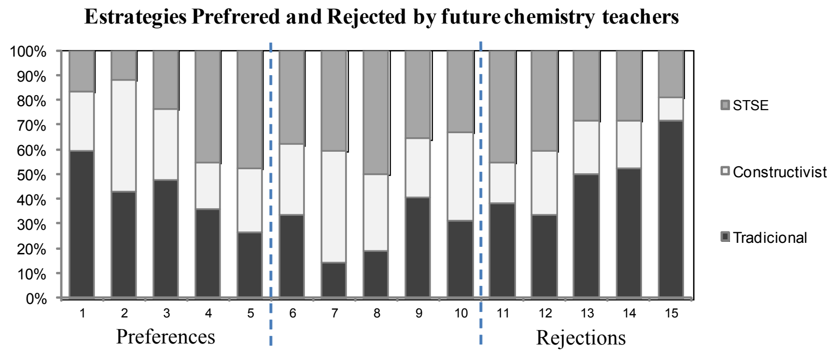
Scientific literacy is a term used in many countries to define the meaning of the science teaching. According to Bybee[1,2,] it means the scientific understanding of the natural world, scientific modes of inquiry, the nature of scientific endeavour, and the historical, social, and intellectual contexts within science is practiced.

This study used Bybee's levels of Scientific Literacy to classify the conceptions of 40 future chemistry teachers from Brazilian Universities about this concept. The levels of SL proposed by Bybee adjusted to this study are presented on the table 1:

Table 1: Levels of SL proposed by Bybee and teaching approach

Levels of SL	Teaching approach
Functional	Tradicional
Conceptual	Construtivist
Multidimensional	Science, Technology, Society and Environment (STSE)

The students had to classify 15 teaching strategies, which the first was the most preferred and the fifteenth was the most rejected when preparing a chemistry class. The chart below shows the results of the first five preferences and the first five rejections:



The data collected indicated that most of students chose a traditional teaching strategy on first and third places, a constructivist on second place, and a STSE only on fourth and fifth places. The most rejected strategies were a traditional on fifteenth place, a constructivist on fourteenth and thirteenth, and a STSE on twelfth and eleventh places.

Since the future chemistry teacher's conceptions transited in different levels of SL, thus these conceptions may be not established as a teaching strategy. Therefore, it demands a better training for the future teachers about this concept.

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PS1.PO15

"STUDENTS OF THE THIRD CLASSES OF PRIMARY SCHOOL AT THE MUSEUM: REPORT OF ACTIVITIES AND FEEDBACK"

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Students of two classes of the Primary School "A. G. Novaro" (Vada – Italy) visited the "Museo di Storia Naturale" in Rosignano Solvay in occasion of the exposition "Le pratiche della chimica ieri e oggi" (December 2011). During their visit at the Museum, students could experience the evolution of techniques and equipments used by Chemists since the Eighteenth up to now. They could experience different activities: 1. Listening some enchanting stories about chemicals and chemists; 2. Observing and touching glasses of various shapes, reactant bottles and tubes, molecular models, filter papers, and so on; 3. Wearing laboratory gloves and glasses and performing real experiments under the guide of experts and animators. Students, stimulated by the animator, were directly involved not only in the realization of the experiment (for instance, the synthesis of Prussian blue or development of gas in a acid-base reaction), but also in the explanation of what they were doing.

After the visit at the Museum, the students performed several activities at School (for example, they had to write a short report, paint their impression from the "hand on" activities, …). From these feedbacks, the teachers could test the level of understanding and the knowledge acquired by the students.

A further step of this educational activity consisted of the visit of the museum's animators to the students (at School): similar experiences and stories about Chemistry were proposed in a different contest (the class). Later on, the evolution of the students' impressions and level of understanding since their first contact with the scientific experiment, were tested.

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ACTIONS REGARDING THE DISSEMINATION OF CHEMISTRY AT *CASA DA DESCOBERTA* – A SCIENTIFIC DISSEMINATION CENTER OF THE FLUMINENSE FEDERAL UNIVERSITY

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This paper describes the main activities regarding scientific dissemination in the field of Chemistry at Casa da Descoberta (CD) – a Scientific Dissemination Center of the Fluminense Federal University. It presents a brief history of CD and discusses the difficulties concerning the dissemination of Chemistry at Scientific Dissemination Centers. This work also approaches some activities developed throughout the years: experiments performed in relation to the visitors' daily life, training of monitors to act as mediators in the non-formal teaching of Chemistry, production of dissemination materials, elaboration of books, as well as activities that relate formal to non-formal education.

Key words: scientific dissemination; chemistry; education

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CHEMISTRY PROPAEDEUTIC CLASSES FOR SCHOOLCHILDREN IN THE POLYTECHNIC MUSEUM

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The Polytechnic museum is the head museum of science and technology in Russia, and one of the oldest museums of this type in the world. The museum's display areas house unique objects from its collections. Apart from that the museum has special laboratories and auditoriums to work with visitors, including the scientific-educational laboratory "Chemistry", the only chemical laboratory part of a technical museum in Russia. One of the main areas of work in the laboratory is providing chemistry propedeutic classes for schoolchildren. The aims of the propedeutic chemistry courses are:

1. Generation and development of interest for chemistry and students' preparation for studying the school chemistry course (years 8 and 9, 14-15 y.o.).
2. Teaching the habit of visiting museums regularly for self-education.

Since 2005 the laboratory offers the "Introduction into chemistry" course – 10 propedeutic classes for groups of students of years 5 to 7 (11-13 y.o.) [1], and since 2009 – the "Ecological chemistry" course – 3 classes for students of years 3 to 5 (9-11 years old). In 2011 the staff organised "The chemistry workshop for children in the Polytechnic museum" – regular propedeutic classes for single visitors 11-13 years old and periodic classes for families with children 7-10 years old. The full propedeutic course is 3 years long and includes over 70 propedeutic classes for children 11-13 years old. The types of the integrated propedeutic classes are lecture-demonstration, practical work and excursion. During classes methods like games (game-travel, game-competition) and performance are heavily used. The "Portfolio of a young chemist", which includes all the works by the student, is an instrument of performance monitoring, assessment and self-assessment by the student.

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PS1.PO18

"DEVELOPMENT OF METHODS AND PRACTICES IN CHEMISTRY LABORATORIES FROM THE 1900 UP TO NOW": A MUSEUM EXPOSITION

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Fig.1. View of the exposition with the reconstruction of a Laboratory desk of the 1900.

In the frame of the International Year of Chemistry 2011, a museum exposition was organized at the "Museo di Storia Naturale" in Rosignano Solvay (Livorno – Italy). In the last ten years, this small museum (http://www.musrosi.org/) has become very active in the organization of cultural events, such as conferences and expositions, and its main mission is promoting Science to young people and to students at Primary, Secondary and High Schools. To this aim, every year the Museum organizes a Museum Exposition dedicated to a specific topic and an intense program of activities open to local school classes is planned. This year the exposition was entitled "Le pratiche della chimica ieri e oggi" and it was focused on the evolution of the Laboratory of Chemistry from 1900 up to now. Starting from the design and optimization of chemical glasses, with their various shapes and dimensions specific for different chemical purposes, the visitors discover the first spectroscopes (i.e. some original instruments from the University of Pisa, used by Raffaele Nasini and later by Camillo Porlezza).[1] Large educational panels introduce them to the modern methods, such as chromatography and nuclear magnetic resonance spectroscopy, now used in almost every Laboratory of Chemistry.

In this work the multi-level structure of this exposition, composed of objects, panels, texts, images and simple laboratory activities is described and discussed.[2,3]

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HISTORICAL DEVELOPMENT OF ELECTROCHEMICAL CELL AND STUDENT CONCEPTIONS ABOUT ITS FUNCTIONING

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From high school to University, students have always faced problems understanding the functioning of an electrochemical cell (Sanger & Greenbowe, 1997; Bouraoui & Chastrette, 1999). A study led by Bouraoui and Chastrette on the conception of conduction in electrochemical cells shows that the majority of students have difficulties assimilating the qualitative aspects of electrochemical processes. For instance, students hardly conceive that a battery works by displacement of ions from one electrode to the other and not by electrons' transfer within the solution. It is worth also mentioning the difficulties in understanding the important role of salt bridge in the functioning of certain electrochemical cells. Several studies in didactics of chemistry propose the introduction of the basic concepts of sciences through its historical developments (Niaz, 2005). Our research appears in this perspective and in the first part; we will present some studies on the conception of high school and undergraduate students with regards to the functioning of an electrochemical cell and electrical conductivity in liquids. In the second part, we will present a historical overview of the work on the invention of the electrical cell and the various theories that have been developed with regards to its functioning from Galvani to Faraday. We will see how Volta who rejected the idea of "animal" electricity as set out by Galvani, proposed an explanation that a simple contact of two different metal coins separated by a paper soaked in brine could produce electricity. Volta incorrectly thought that it was the contact between the two metals that generated the electricity. This explanation which is referred to as "metal" electricity was in turn challenged by other chemists. Following the work of Davy, Berzelius, and others, Faraday carried out quantitative experiments on electrolysis and developed laws relating the amount of electricity produced. He stated that the transfer of electricity in the electrolyte is done through fragments of dissolved molecules (ions). Unlike Davy and Berzelius Faraday gave a great importance to the environment in which the charges move and this opened the way to the development of a new science called electrochemistry. Finally, we will see certain difficulties encountered by scientists in the development of electrochemistry similar to those encountered today by students.

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RESEARCH ABOUT THE ACADEMIC COMMUNITY AND PUBLIC SCHOOLS AWARENESS OF UBERLÂNDIA ON THE APPROPRIATE DISCARD OF THE USED CELL PHONE BATTERIES.

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This paper focused on the mapping of the behavior of the academic community of the Federal University of Uberlândia/UFU and two public schools in Uberlândia, in partnership with the Institutional Scholarship for New Teacher (PIBID- Programa Institucional de Iniciação à Docência) - chemical sub-project program. Initially the project containing an environmental questionnaire partner was submitted to the Ethics Committee of the Uberlandia University to securing the integrity of research subjects. The Bueno Brandão and Américo Renê Giannetti state schools were selected in partnership with the PIBID-chemical sub-project Program. In these schools, theoretical and practical mini courses were conducted witth 65 questionnaires were applied in the Public School of Uberlândia and 169 questionnaires in the academic community of UFU. It was observed in the treatment of the data obtained by questionnaires that the most of the volunteers in the study of both the Public School, the academic population of UFU noted the appropriate locations for the collection and disposal of used batteries only after the application of these questionnaires. Therefore, the most of the respondents drops used cell phone batteries in their own household waste generated and they do not know the locations which have suitable collectors. Besides, they say to be aware of your responsibility but, they consider the manufacturers of batteries and electronic devices like the real responsible. As a result, the majority of the respondents always ends up keeping the batteries or dropping them in the inappropriate places that promote a major environmental impact in the future. Based on the data obtained it was observed that the respondents do not know the locations which have suitable collectors of used cell phone batteries and thus they consider the manufacturers of batteries and electronic devices like the real culprits. The paper goes on the prognosis of raising awareness of the academic community and of the Public School of Uberlândia.[1]

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AN ANALYSIS OF INTERPRETATIONS PERFORMED BY PROSPECTIVE CHEMISTRY TEACHERS ON SCIENTIFIC REPRESENTATIONS.

Muñoz, L; Nardi R

In this paper is made an approach to conceptualization, regarding what can be understood as scientific representations, as well as, the meaning that future chemistry teachers give to these representations during initial teaching activities carried out in a Degree Program in Chemistry, during the process of teaching and learning. Since the representations are used to elaborate scientific explanations to understand how the chemical world works (Adúriz-Bravo; Izquierdo-Aymerich, 2009), the teaching of science is related to the understanding that teachers have on the representations constructed by science and the way these are applied in educative processes.

In order to investigate the attributed meaning to different forms of representing the chemical knowledge and its relationship with the historical and social context, a questionnaire was implemented, to analyze the interpretation on the representation of the chemical structure through verbal and nonverbal languages (Kozma; Russell, 2005). Data collected show that that future teachers representations correspond, in their majority, to ingenuous realistic explanations, mainly to macroscopic explanations and, in a few occasions, relations are established with the symbolic, the microscopic world and their models in chemical education. (Gilbert; Treagust, 2009).

We interpreted future teachers representations using Bachelard (1938) as reference, since it allows us to explain that scientific knowledge formation happens through either, in a concrete stage, where the first geometric representation is based on an ingenuous realism that remains bound to the apparent, followed by a concrete abstract-stage, where the spirit feels more confident of his abstraction, whereas can be represented by a sensible intuition, the configuration of the abstract thought occurs between the constructed forms that separate the immediate experience to enter in a declared controversy with the reality.

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LAUNCH OF THE SPRINGER BRIEF HISTORY OF CHEMISTRY VOLUMES IN 2012

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During 2012, five volumes in the Springerbrief History of Chemistry Series will appear. These will be small volumes, about 100 to 125 pages in length, documenting historical developments in a variety of fields. Their authors and titles are listed below.

- David Lewis – Early Russian Organic Chemists and their Legacy. This volume chronicles the development of organic chemistry in Russia up to the time of the Russian revolution, and highlights some of the important reactions and rules developed by Russian organic chemists, whose biographical information is also briefly summarized. This short book makes biographical material heretofore available only in the Russian language accessible to a wider audience.
- Mary Virginia Orna – The Chemical History of Color. This volume will describe the intersection of the three elements of color, history and chemistry over a 30,000 year period from the ancient cave painters to the role of color in the development of the pharmaceutical industry, and beyond. Several chapters describe how curiosity about color led to discovery of fundamental physical and chemical concepts.
- Gary Patterson – A Prehistory of Polymer Science – A Presentation of the Discoveries and Events Leading up to the Development of Polymer Science. An exploration of the period before there was a coherent community of polymer science is presented (to 1935). The development is followed by discussing the history of natural rubber, polystyrene, Bakelite and the polysaccharides. Another trajectory traces the history of the Faraday Society from 1903 through the pivotal Discussion on Polymerization of 1935 that solidified the community we now know as polymer science.
- Alan Rocke – From the Molecular World – This volume is an annotated English translation of a fantasy about personified molecules by physical chemist Hermann Kopp.
- Seth Rasmussen – How Glass Changed the World – This volume describes the history and chemistry of glass, from its discovery in antiquity to its early applications to chemical glassware and apparatus in the 13^{th}-16^{th} centuries.

These volumes and those to follow will encompass topics in the history and philosophy of chemistry that will be useful in communicating fundamental concepts of chemistry in both introductory and advanced chemistry courses. The viewpoints of both “chemist-historians,” who chronicle the history of chemistry by noting those steps that allow the science to progress forward, and “historians of chemistry,” who explore the contributions to the philosophy of science, intertwining the background of the sociology and surrounding events of the time, are represented in this series[1].

The volumes will be available in both hard copy and as e-books from Springer-Verlag, Heidelberg.

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HISTORY OF SCIENCE IN CHEMISTRY EDUCATION

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Implemetation of history of science should be one from the important goal in contemporary chemistry education. Unfortunately, the Czech national curriculum of chemistry ignores the historical development of chemistry.

We would like to discuss in our contribution a significance of this theme for students in chemistry education. We suppose that history of science could be a means for the integration and the interdisciplinarity of the natural science in education. And not only. History of chemistry shows science from the other side than as „a complex of exact knowledges". It brings to science education stories of people and their inventions. History of science is the example of cross-curricular topics that could be very attractive not only for scientifically but also for humane oriented students. D. Allchin (1992 and 2010) and D. Höttecke (2010) think that the history of science could help to show the „human" dimension to science.

We have been interested in history of science in Czech chemistry education for 3 years. We prepared new didactics material and realized 2 projects for teachers and their students:

- History of Science in Education of Secondary Teachers (study text)
- Prague, the City of Alchemy (guided tour, didactic game, laboratory experiments)

The contribution presents the results of the projects and the didactics issue in an integration of chemistry and history for the periods of the ancient China, the antique Greece, the Middle Ages and the Renaissance in Europe.

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YAC AND THE GLOBAL STAMP COMPETITION

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In IYC 2011 CCE realized a Global Stamp Competition (GSC)[2], encouraging young people to reflect on national chemical developments and to document their reflections by creating a stamp. Students submitted their designs to a moderated publication platform (MTN, UK) that allowed peer review. They used e.g. Facebook to advertise this peer review. The young 1st prize winner from rural Bulgaria used Facebook (tagged pictures) intensively with her peers to show the world! The day after the ceremony an excerpt of the TV registration was uploaded to YouTube[3]. Results of the competition were shown during the IYC 2011 Closing Ceremony in Brussels[4,5].

The ongoing Young Ambassadors for Chemistry (YAC) project from 2004-now[6] aims at young students to promote chemistry through public events. To enable them to do so, the YAC team teaches their teachers (secondary, tertiary) different ways of new content and methodology. New methodology can be achieved in taking part in international projects: using (free) social media like 'Science Across the World' (hosted by ASE)[7] with around 2000 unique page views per month, the SAW Facebook group[8], E-twinning[9], available in most European languages (e.g. for EU Comenius school partnerships) and the (moderated) FactWorld[10] platform to find partners, content and ideas. Groups of students study and explore meaningful content in their local context and share outcomes in work spaces (e.g. E-twinning's Twinspace, global participation permitted), prepare mutual reports, presentations with pictures (Animoto[11]) and videos (YouTube).

During the public event they share their local/national results with the public, interact and afterwards they produce picture shows and videos to share on social media with their partners. In privileged countries with more advanced equipment available, smartphones and tablets can add new dimensions[12].

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INQUIRY-BASED LEARNING IN THE CONTEXT OF WATER IN LOWER SECONDARY SCHOOL

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Previous studies have shown that students see chemistry as irrelevant to their future.[1,2,3] As their interest can be affected by the context of their chemistry lessons[1,4] and by using inquiry-based practical work[5], the object of this study was to examine the effect of inquiry-based practical work on (i) students' interest in chemistry of water and (ii) their interest in studying chemistry in the future. This study was performed using a postal survey that was sent to a two lower secondary schools participating in the Water: A Chemical Solution project. The project was launched by IUPAC and UNESCO as a part of the International Year of Chemistry 2011 and it consisted of four different inquiry-based practical works, which studied the state of natural waters.

The answers from the survey (N=86) were analysed using statistical methods: cross tabulation was used to detect correlations between the students' background and different aspects of chemistry of water and factor, and factor analysis for defining the effect of the practical work on students interest. Various statistical methods were also used to increase reliability of the study.

The study showed that the interest in the different aspects of chemistry of water correlated with the students' general interest in chemistry, positive attitude towards practical work, and on how well they succeeded in their chemistry studies. Two-sided statistically significant (significance level 0,01 or 0,05) correlation was detected between all but one aspect of chemistry of water. Some aspects, for example "water purification", were seen generally interesting and other aspects, for example, "chemical properties of water" were interesting only if the student was interested in chemistry.

The results of the study also indicate that using inquiry-based practical work that Water: A Chemical Solution project contained may have an effect on the development of the students' interest in chemistry. The results indicate that some students' personal, long-term interest was affected, even though this effect on interest-development was observed only in the minority of students.

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IYC 2011 ACTIVITIES FOR THE TAIWAN HIGH SCHOOL STUDENTS

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Guidance by the chemical society located in taipei, The Chemical Educational Resource Center of Taiwan handle iyc activities. A total of 10 high schools participate in iyc activities. Design Fun chemical experimental barriers. To mobilize thousands of student volunteers as experimental commentator. Total to participate iyc activities more than 11,000 students.

Emphasis on the fun and creativity of the experimental operation. Experience the skills and methods of chemical experiments

TOPIC: INQUIRY- AND PROJECT-BASED LEARNING ABOUT PLASTIC AND PLASTIC WASTE

Ganajova, Lechova

The paper points out common features and significance of research method in project-based teaching of the topic Plastic and Plastic waste. Over the years we have organised courses on project--based method for chemistry teachers, in 2011 we organised courses on teaching research-based method for science teachers. The project-based method has been implemented as team work on a relatively broad task, its output being posters, presentations, radio presentations, displays of pupils‘ work, etc. Pupils have projects on such topics as It is an incineration plant to blame, To recycle or to throw away, etc. With the help of the teacher pupils suggested topics, aims of the project, common planning, implementation and presentation of results, evaluating of results, etc. Different forms of research-based method, such as the experimental part in which pupils tackled tasks focused on properties of plastic materials or the theoretical part, eg. kinds of plastic materials and their labelling , or tackling a research task focused on recycling of plastic materials, their decomposition in soil, etc. were used in project work. This kind of project-based teaching is marked with its research character. The teacher guides a pupil in a way similar to the one common in real research. This enables a pupil to state a problem, suggest a method to solve it, solve the problem and thus acquire the necessary competence, knowledge, skills and communication skills in a relatively independent way and in co-operation with other pupils.

In the above research activities mainly the following methods were used :Guided inquiry - in this case, students work in teams on their own experiment - eg. they were trying to find out density of different plastic materials in comparison with that of water and Bounded inquiry - same as in the above, but in this case students are expected to design and conduct the experiment themselves with little or no guidance of the teacher and only partial pre-lab orientation. Example: “What impact does acid rain have on plastic products“. The research problem to be solved is given to them by the teacher, but they have the responsibility for designing and conducting an experiment

The efficiency ot the above methods was evaluated by means of scale-based questionnaire for project-based method as well as by ESTABLISH tools for determining the influence of IBSE on pupils‘ learning. The results of the evaluation revealed that pupils liked the activities very much, the interest in science increased in pupils and due to the topic their environmental awareness increased as well – they started to start separation of waste not only in school but also at home and their neighbourhoods. Teachers pointed out possibilities of incorporating the topic into chemistry teaching as well as making it contents of an interdisciplinary topic Environmental education at basic schools.

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JOURNEY AROUND CO_2: AN INTERDISCIPLINAR COURSE

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This experimental course comprises interdisciplinary teaching laboratories having CO_2 as a common theme. This compound is of particular interest in several scientific fields: from chemistry itself to biology, geology and environmental science. The experiences were numerous and varied in each field of interest. Among the most important we mention the measurement of its density and solubility; CO_3 - / HCO_3- equilibrium in the development of karst; the relationship between dissolved CO_2 and oceanic waters acidity and its impact on the development of the calcareous shell of molluscs; the buffering effect of carbonic acid in the blood; redox reactions with CO_2. The course is highly interdisciplinary and the laboratorial approach gives the opportunity to investigate complex systems such as biochemical- and geochemical- ones using ways appealing to the students.

The project is part of "Piano Lauree Scientifiche" in collaboration with the Department of Chemistry and Geological Sciences at the University of Cagliari and involved N°x high-school teachers and N°x students.

During the first phase the teachers discussed the project and made bibliographical and webographical researches in order to select the most significant experiences, experimented them personally and elaborated the didactic units which comprise the course. During phase two the didactic units were presented to the students who completed the selected experiences in the laboratories at their own school and at the Department of Chemistry at the University of Cagliari.
Phase three consisted in the students reprocessing the material and preparing the final reports.

The collaboration between teachers from different university study courses in this work of research has made possible a mutual enrichment by sharing experiences and to improve the expertise of the participants.

The students showed a great appreciation for this initiative which granted them the opportunity to deepen their knowledge and competence in the scientific field, to get closer to the university world and to realize how important chemistry is in understanding many of the phenomena of this world in which we live.

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FREE AND OPEN SOURCE TEACHING-LEARNING MATERIALS FOR AN EXCITING LEARNING EXPERIENCE

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The scope for learning subjects in our own way via flexible learning module is relevant in this age of tablets. The paradigm shift in globalized learning using multiple sources is reflected in the recent trends, practices and techniques among students/facilitators. The present situation of academic non-performance needs some specific and alternate methods to discuss a subject, impart knowledge, instill basic values and for total education. The power point slide show involving sights and sounds on a variety of science, engineering and technology topics offers significantly more visually stimulating experience than traditional teaching tactics. The papers published in open source journals incorporating quality teaching-learning content by specialists in subjects with a significant involvement in subject information provide an alternative source of knowledge. These methods stir the imagination to influence the thoughts and deeds of the future generation and have implications in health, education and prosperity with the advantage of subject areas, supplementary reading material and value addition. The disciplined learners can use visualization technique as a primary method of learning to gain knowledge and understanding to increase confidence levels in the changing times.

URBAN SOLID WASTE IN EUROPE: DEVELOPMENT, INFLUENCING FACTORS AND A CROSS-CURRICULAR TEACHING CONCEPT

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*Th*e correct estimation of the accumulation of urban solid waste is an essential feature in the planning process of an efficient waste management system. Misjudgments have effect on the positioning as well as quantities of the supplied containers. This may lead to elevated costs and negative influences upon quality of life and environment. In order to limit this, the influencing factors of the urban solid waste arisings must be sufficiently known.

The first part of this poster examines the development of urban solid waste management in Europe, pointing out particular differences in quantities and treatment methods[1.] That is, e.g. each Danish citizen produces a mean of over 800 kg of waste per year, while this value decreases to a mere 300 kg in Poland. And concerning treatment methods, the nearly 100% landfill waste deposition applied in most eastern European countries stands in clear contrast to the fifty-fifty recycling and waste combustion methods implemented in countries like Germany, Switzerland and Austria.

To explain these differences, the second part of this poster takes a closer look at the different control parameters of waste accumulation. Those are mainly socio-economic and comprise, amongst others, the level of production, the gross domestic product, the level of education, the per-capita income and the consumer habits.

Due their growing global relevance, the topics „waste" and „waste management" should also be a subject in class. The third part of the poster accordingly outlines the structure of a possible teaching concept of these topics, whereas their multidisciplinarity represents a special challenge. This is taken into account through the transversal incorporation of chemistry, geography, mathematics and economy class into the teaching concept.

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TAKING SCIENCE COURSES AS A MODERATOR OF RELATIONSHIP BETWEEN PUBLIC RISK PERCEPTION OF SCIENCE AND ATTITUDE TOWARD WATER RESOURCES

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This study focused on investigating the relationship between public risk perception of science (RPS) and attitudes toward water resources (AWR). One hundred and two Taiwanese citizens were surveyed by in-person interviews. The quantitative analyses adopted in this study were regression and mediation analyses. The results showed that the RPS was a predictor for the AWR ($R^2 = 0.090$, F=9.663, p <.001). Using citizens' background in taking high school science courses as a moderator, a difference was found between two groups. In the group who took high school science courses, AS was still a predictor for AWR ($R^2 = 0.211$, F=10.136, p <.001). In the group who did not take science courses, RPS was no more a predictor for AWR (F=2.999, p >.05). This difference between groups revealed that taking high school science courses was necessary for promoting citizens to have positive attitudes toward science related issues from the daily science communication.

Keywords: *risk perception of science, attitudes toward science, mediation analyses, water resources.*

CHANGING HOW WE TEACH FIRST YEAR CHEMISTRY

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In South Africa students failing chemistry, physics and mathematics are a major contribution to the low graduation rate of programmes in science and engineering. The first year at university is the bridge between formal schooling and the successful graduate. If the times we live in and the changes formal education has moved through create different needs, the way we teach chemistry needs to change.

Chemistry 1A is a compulsory first semester subject for several programmes offered in both the Faculties of Science and of Engineering at Tshwane University of Technology (TUT) and each year between 350 and 500 students register for the subject. Prior to 2011 two lecturers were assigned and the subject content divided between them, each presenting half of the material in his/her own style. In spite of several attempted interventions the pass rate for this subject fell to only 40% after the first semester of 2010. It was evident that a different strategy was urgently needed to overcome the problem.

The change made to teaching first year chemistry in 2011 was to create a more inter-active classroom environment. The lone lecturer presenting the subject content from the podium was replaced with three lecturers working together as a team. The lecture topic was briefly introduced and the lecturers then moved throughout the lecture hall stimulating student participation by promoting discussion and inter-active questioning which prevented passivity amongst the students.

Changing the way we teach enabled students to improve their understanding of chemistry and the improvement was reflected in the final examination results. An improvement from 40 % in 2010 to 76 % in 2011 is evidence of the difference which was achieved by changing the way chemistry was taught. The quantitative aspect of the study will use the statistical evaluation of test results, predicate and examinations marks and compare these with those of previous years.
Questionnaires and focus group interviews of a stratified random sample of students, both those who passed and those who failed, will be used to present the students' experience qualitatively and attempt to explain the underlying reasons for the success achieved.

4C-STEAM EDUCATION IN KOREA

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STEAM Education refers enhancing science, technology, engineering, arts and mathematics by interdisciplinary approach. STEAM Education fosters integrative. STEM education with artistic perspectives. Korean students have high academic achievement in math and science, but show low self-efficacy and interest in them. We highlight the affective aspect of science-technology-mathematics education on STEAM, 4C-STEAM stands for convergence, creativity, communication, and caring. The key elements of 4C-STEAM are creative design and emotional touch. 4C-STEAM education will help students: To possess integrative understanding and problem-solving ability in STEAM subject areas to become competent citizens in future society; to have interest and curiosity in STEAM subject areas to bring high self-efficacy and strong motivation; and to be considerate of others' feelings.

Key words: STEM, STEM-Arts, STEAM, 4C-STEAM, Integration, Science-Technology-Engineering-Arts-Mathematics, Creative design, Emotional touch

ETHICS AND CHEMISTRY: INTRODUCING THE CHALLENGE TO SECONDARY SCHOOL STUDENTS

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Chemistry is one of the sciences with the greatest potentialities for the improvement of human life, environmental conservation and preservation of nature. But the huge possibilities of chemical applications could have very negative implications if choices do not consider all the potential impacts. The opportunity to guide choices in a constructive way is linked to a "culture of responsibility" that needs to involve research, professional figures in various areas, economic management, but also political and individual choices. In order to accept this cultural challenge and to celebrate the international year of chemistry, our secondary school has organized a meeting titled "Ethics and chemistry: a possible dialogue? The school promotes the challenge".

Chemistry is linked to many different areas of thought and research and has an important role in several industries. , we chose the speakers in order to highlight this plurality of points of view as well as the globalisation of chemistry activities. The invited speakers comprised three university professors in chemistry or applied ecology (including one from South Africa), four executives of chemical companies with international trade, a German researcher of an international chemical company, an economist and an expert on ethics. The meeting took place on December 19.

The preparation of the meeting involved the collaboration of many parties: several teachers of different subjects (chemistry and life sciences, philosophy, physics, Italian and English), laboratory technicians, parents' representatives and students. More than fifty students participated actively in the preparation, reading and translating articles on the conference theme, managing the contacts with the speakers and interviewing some of them. They also prepared a video on the history of chemistry to be shown at the meeting opening. We also collaborated with Unindistria (Union of Industrialists and Enterprises) and Ordine Nazionale dei Chimici (Italian Council of Chemists). Over four hundred students attended the meeting, and many of them interacted with the speakers, both during discussion sessions and informally. They showed an encouraging good level of participation and satisfaction. The overall impact on students' perceptions about chemistry was positive.

The presentation outlines the motivations of the initiative and the challenges and options of the preparation stage, and discusses students' responses. It is concluded that the initiative highlights the importance of involving students in multidisciplinary activities to broaden their outlook on individual sciences and to encourage personal commitment.

STRATEGIES TO IMPROVE THE TEACHING, RESEARCH AND PUBLIC IMAGE OF CHEMISTRY

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Chemistry is a core field of Science that is used to foster an understanding of the characteristics and changes that occur in everything that has mass and occupies space. Chemistry has permeated the study of different branches of Science. The teaching and understanding of the fundamentals of Chemistry are very important for the training of students at all levels. Research in Chemistry is vital to sustain life on our planet. Chemistry also plays an important role in our daily life and therefore it is important to have a good public image of Chemistry.
This poster aims to highlight the following:

(1): Teaching of Chemistry:
The teaching of Chemistry cannot be limited anymore to blackboard or only one learning environment. We are in the ICT age and ICT should be incorporated in our teaching methods. There should be a paradigm shift to problem based interactive learning with more practical and activities. The right teaching approach is one of the factors, which promotes learning and interest in the subject. It is important for students to be captured by the excitement of Chemistry using experimental learning as they will be our future Scientists.

(2): Research in Chemistry:
Research in Chemistry is fundamental to achieve sustainability on our planet Earth. Research in Chemistry can help to: (i) clean the environment, (ii) clean water and air, (iii) increase crop production, (iv) produce better clothing materials, (iv) have more efficient drugs, (v) have renewable energy sources, and (vi) have more efficient ways to store of energy.

(3): Public Image of Chemistry:
Chemistry has a bad public reputation although Chemistry is involved in each and every aspect of our life. The public image of Chemistry has to be improved by making people aware of the wide applications of Chemistry, and understand how our lives have been vastly improved by applications of Chemistry. One aspect, which is usually forgotten, is the safety issue with chemicals.

We hope to have participants for brainstorming in order to have ideas so that Chemistry can serve to the betterment of mankind. This poster also meets the objectives of the International Year of Chemistry, IYC 2011 and the UN Millennium Development Goals.

SUSTAINABLE DEVELOPMENT IN CHEMICAL EDUCATION

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Over the last three decays, the world has undergone deep transformations. The environmental issues are in the foreground, with the concerns for the North-South disparities; globalisation and international migrations require a new governance of development processes at international level. The degree of attention paid to environmental issues has become extremely significant. In this context, the "sustainable development" has become an inevitable reference for all local, national and international institutions, companies and other organisations who are willing to integrate economy and environment more consciously, without making the latter become solely an obstacle for the first. Schools cannot be indifferent: there is a growing educational need in this field [1]. Sustainability poses challenges that need to be brought into the chemistry curriculum, connecting chemistry learning to the broad goals of education, especially to the ethical aspects [2]. This work shows how chemistry teaching in an Italian high school can focus on the interplay of science, technology and society with regard to local issues, public policy-making and global problems. In particular, these topics have been used to teach how fields such as economics, politics and law interact with the chemistry curriculum:

- Registration, Evaluation and Authorization of Chemicals (REACH)
- Classification, Labeling and Packaging (CLP)
- Life Cycle Assessment (LCA)
- Green Public Procurement (GPP)

Teaching sustainability is more effective if the school institution adopts a green policy. In particular, GPP means to represent a valuable teaching support and an effective environmental policy tool for schools [3]. Since schools are usually not accustomed to Green Procurements, the GPP could be achieved in steps - starting with a small amount of products to be increased in time. All the managing policies should be strictly related to teaching environmental education, considering chemistry as a subject that cannot be omitted.

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STUDENTS CHANGING ATTITUDES TOWARDS LEARNING CHEMISTRY AMONG SCHOOL CHILDREN AND UNDERGRADUATES IN PAPUA NEW GUINEA

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Chemistry has not been very popular subject among school children and undergraduates in many countries. Until recently this has been the case in Papua New Guinea (PNG) too. Changes in circumstances and some of the measures taken by the Department of Education and the author appear to have changed the attitude of the students and chemistry is becoming quite popular among students. Introduction of a new chemistry syllabus with emphasis on natural resources based industries and chemical practices of ancient Papua New Guinean may have influenced school children becoming more interested in chemistry. About five years ago, the author set about introducing several measures to make chemistry more attractive to undergraduates. They included the use of information technology, the introduction of weekly industrial visits, and work experience programs, moving away from lectures, tests and examinations being memory based to those based on understanding concepts and processing of knowledge, making learning more student centred than teacher centred and last but not least, addition of some humour to chemistry. This paper details these measures which most probably have led to a significant turnaround in students' attitude to learning chemistry and its increased popularity among them.

CREATIVE GENERAL CHEMISTRY EXPERIMENTS WITH CITRUS FRUITS

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We have developed creative variations of three standard general chemistry experiments that use citrus fruits: 1) Exploring the electrical power that can be generated by the pulp, 2) Measuring chemical and electrical properties of the juice, and 3) Discovering a practical and novel use for the peel (only the epicarp). These simple but elaborate experiments provide some proof of fundamental chemistry theories, including a) electron transfer between the anode and cathode (the redox reaction); and b) the relationship between conductivity and the concentration of electrolytes, and c) characteristics of substance polarity and solubility. It also introduces the use of pH and multi meters, and introduces the lab skills of titration, extraction, and data analysis, among others. In addition, practical elements are covered to increase the students' interest, including light-sound effects such as lighting up an LED, and making the fruit "sing". Lastly, making citrus detergents will help students to be more aware of the issues of recycling and being environmentally responsible. In these experiments, students can not only understand the necessary scientific knowledge, but can also learn common lab skills for making a practical product that has uses in everyday life.

Table 1: Experimental Purposes, Theories, and Highlights of the Citrus Fruit.

	Pulp	**Juice**	**Peel**
Experiment	Fruit Battery	Vitamin C, pH, and Conductivity in Citrus	Homemade Zest Detergent
Purposes of Experiment	Discover the factors that affect the electrical power of a fruit battery cell	Measure the qualitative and quantitative properties of citrus juice	A use of fruit peel in everyday life
Experimental Theories & Skills	Redox reaction Electron transfer Reduction potential Electrochemistry	Redox titration Starch indicator Data analysis Solution preparation	Extraction Molecular polarity Solubility Solvent property
Experimental Highlights	Illuminate an LED & activate a music chip to play a tune	Observe the relationship between juice concentration and conductivity	Emphasize the concepts of recycling environmental responsibility. A green chemistry experiment

EFFECTS OF TEACHING USING ANIMATIONS ON ACADEMIC ACHIEVEMENT IN THE TOPIC OF "PRECIPITATION TITRATION"

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Recent research on science education indicates that the most significant problem educators face is students' underachievement as a result of traditional teaching methods. Furthermore, students are reported to have inability to comprehend the topics and their learning does not last for a long time. It is also argued that students are passive recipients of the information delivered. Research suggests that those teaching methods that lead to active student participation should be employed instead of traditional teaching methods to overcome such problematic cases (Hewson et al., 1984; BouJaoude, 1991; Stavy, 1991; Guzzetti, 2000; Özmen and Kolomuç, 2004).

In regard to chemistry education, it is found that computer-assisted teaching method involving CD and computer animations helped students to have higher achievement levels in contrast to traditional lecture method of teaching. It is also argued that chemistry courses will be more joyful, enjoyable and lasting when chemistry teachers have the skill of delivering the course employing computer animations and when the chemistry curriculum is designed in accordance with this delivery technique (Tezcan and Yılmaz, 2003).

Based on these views, this study seeks to determine the effects of using animation-assisted teaching materials based on 7E model on the student achievement in regard to the topic of "precipitation titration".

The sample of the study includes student teachers taking the course of Analytical Chemistry in Hacettepe University, the department of Chemistry Education during the academic year of 2011–2012 and chemistry vocational high school students. The data were collected using those data collection tools that produced both uantative and qualitative data. Concerning quantative data, the study design used was pre- and post-test with a single group. Qualitative data were collected through semi-structured interviews.

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DEVELOPMENT OF MATERIALS INVOLVING ANIMATIONS ABOUT "PRECIPITATION TITRATION" BASED ON 7E MODEL

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In the recent period, computer-assisted education and teaching materials involving animations are commonly emphasized in chemistry teaching. In our country, the Ministry of Education provides computers and Internet software to the schools in order to support such an approach. However, many schools in Turkey have the classrooms of information technology (IT), whereas these schools mostly lack of course materials (Dulger, 2004). One of the significant barriers in making the computer-assisted education more common is the need for high-quality software (Saka and Yılmaz 2005). Those softwares developed without necessary pilot research by software specialists are not at the position of meeting the educational expectations (Dulger, 2004). Therefore, further research is needed to develop high-quality and effective teaching softwares. This study seeks to develop animation-assisted teaching materials based on 7E model concerning the topic of "precipitation titration" that is part of the chemistry course. At the first phase, story sheets were developed based on the content chosen by the authors and then, these were transferred to computer environment using the Visual Basic and Flash programs under the supervision of two computer specialists and educational technologies specialists. At the second phase, this software was implemented within a pilot study during the academic year of 2011–2012 in Ankara. Then, the software was finalized using the feedbacks obtained from the pilot study. The study presents the experiments under the topic of "precipitation titrations" developed in accordance with 7E model. In the software developed, precipitation titrations are categorized into three sub-groups as the methods of "Mohr, Volhard and Fajans". And for each method, activities, scenarios and experiments are designed taking into consideration the stages of the 7E model, namely elicit, engage, explore, axplain, elaborate, evaluate and extend. Therefore, it is thought that the study will provide the teachers with resources and help the students to meaningfully learn the topic. At the stage of elicitation topic was related with daily activities and a scenario that was enriched through visual materials was employed. After determining the prior knowledge of the students concerning precipitation titration by asking related questions, the students were given a new scenario based on that used at the elicitation stage that included a problem situation. Then, they were asked to design an experiment to solve the problem. The experiment was carried out through interactions of the students. The objective of the experiment was to raise the students' awareness about the experiment. The other part of the activity included developing tables related to the experiment, drawing and interpreting the graphics and calculating the result of the problem. At the stage of extension, the students provided with the opportunities to deeply learn the correlations between variables and to develop connections between these variables and daily life activities. Finally, at the stage of evaluation the students learning was determined.

EFFECTS OF VISITS TO SCIENCE AND TECHNOLOGY MUSEUM AND FACTORY ON THE STUDENTS' UNDERSTANDING OF THE RELATIONSHIP BETWEEN CHEMISTRY, SOCIETY, TECHNOLGY AND ENVIRONMENT

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The globalising world requires that everything should be reconsidered and reevaluated, and that the results drawn from this process should be used positively. Therefore, chemistry education should also be reconsidered in terms of every dimensions. Chemistry educaiton should have the following qualities: student-centered, avoiding route learning, active learners and active teachers, focus on producing high-quality learners, practice oriented, involving real life topics, discovery oriented and focus on the ability of thinking, reasoning and interpreting. This study attempts to develop a chemistry education approach involving the qualities mentioned above.

In this study, the students are provided with an environment that offered them the joy of doing an activity, learning and discovering to make them informed about technological development and industry. The study seeks to determine the effects of the learning activities on the students' behavior and understandings about the relationships between chemistry, society, technology and environment (CSTE).

The effects of visits to the Public Bakery, Middle East Technical University, Science and Technology Museum, General Directorate of Mineral Research and Exploration, Energy Park and History of Nature Museum on the student behavior and their understanding of CSTE were examined. Also, the factors that were thought to have a potential effect on correlations were analysed. These factors are lecturing style of the teachers, socio-economic status and gender of the students, and school types (i.e. public high school, private high school, vocational high school and Anatolian high school). The sample of the study includes a total of 124 ninth-grade students in Ankara and five chemistry teachers. The data of the study were collected through the use of Scientific Attitude Inventory and special working questions that were administered in a pre- and post- treatment manner. The findings obtained indicate that the students' behavior varied between those students who participated in visits and those who did not. The other factors analysed are found to have no statistically significant effect on the students' behavior and their understanding of CSTE connections. More specifically, the students participated in the visits are found to have more awareness about CSTE connections.

Key words: chemistry education, the relationship between chemistry, society, technology and environment, museum and factory visits.

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PRE-SERVICE CHEMISTRY TEACHERS' CONCEPTUAL UNDERSTANDINGS ON FACTORS AFFECTING CHEMICAL EQUILIBRIUM: A CASE STUDY

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Meaningful learning is important in science education since it enhances students' conceptual understanding through connecting existing knowledge with new information[1]. Students' cognitive structure plays an essential role in this process. For effective teaching, therefore, teachers should identify what their students know about the subject to be taught and consider students' mental models during instruction. Students might use chemical representations to develop their mental models. These representations may improve conceptual understanding of chemistry concepts, particularly ones with abstract nature like chemical equilibrium[2]. Chemical equilibrium has been considered to be one of the difficult topics to learn and teach in chemistry education for years[3]. Research studies indicated that pre-service teachers had learning difficulties in understanding chemical equilibrium[4, 5]. As a result, they may not help their students understand this concept meaningfully when they start teaching. Therefore, in this study, we examined pre-service chemistry teachers' mental models about how temperature and concentration change affect chemical equilibrium state. Case study was used to deeply analyze the pre-service chemistry teachers' mental models. An open-ended question was administered to nine pre-service chemistry teachers. Based on their scores, semi-structured interview was conducted with three of them to get detailed information about their mental models. For data analysis, coding categories were used to classify participants' responses. Results indicated that participants could explain the effect of temperature and concentration at macroscopic level by applying Le Chatelier's principle, but they could not clarify these effects at microscopic level by addressing collision theory. Thus, it can be said that the pre-service teachers possessed weak conceptual understanding of chemical equilibrium. Chemistry educators should consider microscopic level while explaining chemical equilibrium to promote meaningful learning and improve learners' mental models.

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POETRY FOR CHEMISTS: AN EDUCATIONAL TOOL

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With few exceptions, Chemistry and Poetry appear to be immiscible academic endeavours. Yet as far back as the Middle Ages, and perhaps earlier, alchemical writings were embellished in artistic, poetic phraseology. In this presentation the author, a synthetic organic chemist by training and a poet by evolution, will describe his use of chemistry poetry in the classroom as a medium to describe chemical principles and ideas. Representative poems of the author's, as well as some originating from students, will be presented in an attempt to bridge the chasm. Poetry then may well be used as a vehicle for teaching and expressing the beauty of Chemistry.

LECTURING PHYSICAL CHEMISTRY AT A SOUTH AFRICAN UNIVERSITY : MISCONCEPTIONS, ANALOGIES AND TEACHING METHODS

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After lecturing physical chemistry, and other chemistry fields, at a South African University (and before that at a Technical Institute) for 36 years, the author would like to share his experiences with a wider audience of chemical educators.

The lecture will cover misconceptions among students, such as handling ΔT in the same way as T, the rule of three, straight lines and the use of units. In addition, numerous analogies will be given which help to understand such concepts as monolayer, Pockel's point, the rate-determining step and others.

Everyday examples and practical applications are used, where possible, to illustrate physical chemistry concepts. Furthermore the exact meaning of Greek- and Latin-derived terms are explained emphasizing the original meaning.

Finally, the author has always believed in " learning through practical work " and some selected physical chemistry experiments, noted for their educational value, will be discussed.

Materials Science in the Undergraduate Curriculum

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The incorporation of materials science in the undergraduate curriculum is a challenging task due to the fact that it is a broad field. To effectively teach a course in this area requires a considerable amount of resources, especially in terms of equipment/instrumentation. In this oral presentation the challenges involved in teaching a course in materials science at the University of Prince Edward Island will be discussed, as well as how these challenges have been surmounted. The topics covered in this course will also be highlighted, and the success of this course in terms of students' benefits and satisfaction will also be presented.

NAÏVE CONCEPTIONS ABOUT THE NATURE OF SCIENCE AND TECHNOLOGY

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To catalyze change in chemical education it is important to stimulate reflection about Chemistry which, as an experimental discipline, is part of a "scientific culture, a social habitat in which disciplines coexist and dialogue without losing their own specific individuality"1. For that purpose, it is important to know the teachers' views on the Nature of Science and Technology (NS&T) in general, as they affect their way of teaching chemistry. In this work, some of the results obtained in Argentina during the development of the Ibero-American Assessment of Attitudes Related to Science, Technology and Society Project (PIEARCTS) are presented. We conducted the Questionnaire of Opinions on Science, Technology, and Society (COCTS)[2] amongst a sample of over 800 people from the education sector (teachers and students). COCTS was distributed into two 15-item research booklets (F1 and F2). Each of the items had to be answered with an opinion about some phrases related to the same argument, classified by experts into three categories: naïve, possible, and adequate. The answers in both booklets that got the lowest scores were the "naïve" categories. The F1 lowest score obtained was that of the item related to decisions by consensus in the scientific community, which states that the scientists who propose a theory must convince other scientists giving conclusive evidence of the theory. The F2 lowest score was that of an item related to a definition of technology that states that it is the application of science. The results show that, in the case of statement F1, the sample of undergraduates from Exact and Natural Sciences (E&NS) that are finishing the course of studies showed a significantly lower score than their peers from Social Sciences and Humanities (SS&H) and, still more worrisome, those who got the worst score at all were men university teachers (training and in-service) of E&NS. In statement F2 E&NS trainee teachers got lower scores than their SS&H peers. The results seem to indicate that many teachers still have not understood that "the natural sciences do not describe the 'truth' about the real world, but powerful and rigorous ways to intervene on it with thought, speech and action"[3].

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PROGRESSIVE TRANSITION OF CHEMISTRY TEACHERS' MODELS OF CHEMICAL KINETICS TEACHING BASED ON THE STUDY OF HISTORICAL DEVELOPMENT OF THIS SUBJECT

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Chemical kinetics in high school is regarded by teachers as a complex topic to be taught since it comprehends explanatory theoretical models (including mathematical models) besides descriptive empirical approaches[1.]

Considering these difficulties the aim of this study is to investigate how a historical approach can facilitate progressive transitions in chemistry teachers' models of teaching chemical kinetics taking into account their decisions about the selection of content and teaching strategies.

This study is based on 20 in-service teachers who had enrolled in a 40 h course on chemical kinetics focused on its historical development (historical reconstruction2). The course aimed to promote the understanding of the historical context in which the kinetic concepts were developed.

According to Lakatos3 science program perspective, it was built models for chemical kinetics teaching based on the teachers' conceptions manifested by their answers to the course activities. We look for models which represents sequences of progressive transitions similar to what Lakatos has referred as "progressive problemshifts" in the history of science4. The evolution of the teachers' models were related to the understanding manifested by them of specific content of chemical kinetics as well as the comprehension of the historical development of chemical kinetic concepts and models

In the beginning of the course, the teaching models were mainly based on macroscopic aspects of chemical kinetics like the factors that affect the rate of chemical reactions. Only five teachers represented microscopic aspects in their teaching models. However, some teachers experienced a progressive transition by building teaching models based on the understanding of microscopic explanatory model of chemical reaction rate as well as on the understanding of the nature of science.

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WE HAVE CHEMISTRY! A NATIONAL PROJECT TO ENCOURAGE CHEMISTRY STUDIES IN ISRAEL

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Recently, studies revealed that the interest, attitudes and motivation of students towards science learning, decline towards the end of elementary school and especially during the middle school [1- 6]. One way to promote students' motivation is engaging them in various competitions, which are popular all over the world. For example, in the 'Internetsymposium' 16-17 year-old students from several schools carry out a chemical experiment and discuss their research [7]. Also, the "FameLab" competition in which students are requested to speak about scientific topics within three minutes. The IUPAC internet site [8] also suggests a few ideas about competitions for the International Year of Chemistry 2011. This includes an essay competition "Chemistry-our life, our future", and an international picture contest "Everything is Chemistry".

In this paper we present a national competition for various chemistry related projects "Chemistry, Industry, and the Environment in the eyes of the individual and society". The associated research evaluated students' motivation (a) to participate in the project and (b) to study chemistry. We were also interested in students' attitudes toward chemistry in general. Our project was aimed at motivating students to participate in a national competition regarding Chemistry and its contribution to everyday life. It sought to encourage the students to study chemistry by demonstrating its relevance and applicability to various areas in their daily life. In 2010, the third round of the national competition took place. High-school students from all over the country were invited to take part in five parallel competitions: Preparing a short video, poster, newspaper report, Lab inquiries or photographs competition. Each competition had different assessment criteria according to the unique product, but all of them demanded to include a proper scientific background and relevance to daily life. Project's evaluation was made by (1) 86 Lykert-type (1-5 scale) items (The items was validated by 3 science-education researchers, internal reliability for each category was calculated ($0.6<\alpha$ cronbach<0.8). The mean score for each category/item was calculated and a matched t-test procedure was completed while comparing the students' motivation items/categories at school towards project), (2) An open-ended questionnaire (aiming for information regarding the way students' collected data, the kind of assistance that they used (or needed) and some reflections regarding their learning throughout the projec) and (3) interviewes. Triangulation was obtained by the three data sources – the lykert-questionnaire, the open-ended questions and interviews. The results of these analyses will be presented at the conference.

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DEVELOPMENT OF INSTRUCTIONAL PROGRAM DESIGNED FOR STUDENTS TO FORM CONCEPTION OF PARTICLES' COMBINATION: A CASE STUDY OF JUNIOR HIGH SCHOOL CHEMISTRY

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Junior high school students (grade 8) in Japan learn that chemical reactions mean changing of atoms' combination. However, they have conceptual difficulties in transferring between a real phenomenon and a representation of a theoretical model in chemistry. In this study, an instructional program is developed in order to deal with such a problem.

The content of the developed program is constituted: (1) "What does a material consist of?" (atom and molecule), (2) "Why does a sponge cake swell?" (decomposition of sodium hydrogencarbonate) and "What happens when silver oxide is heated?" (decomposition of silver oxide), (3) "What happens when water and hydrochloric acid are electrified?" (electroanalysis of water and hydrochloric acid), and (4) "How to represent a material" (chemical formula). On the other hand, the content of the regular program is constituted of the aforementioned (2), (3), (1), and (4). The instruction of the developed program therefore starts from the content of atoms' existence and combination. The students who are taught this program repeat predicting what products will be formed through the chemical reactions shown in the contents (2) and (3) while thinking about atoms' combination.

The trial lessons based on the developed program (for 115 students as an experiment group) and the regular program (for 75 students as a control group) were carried out for one month from October to November 2011. The evaluation of the developed program was done through questions given to the students, in which they were required to represent chemical reactions by using particles' models. The first question as a basic task was to represent a change: "Iron melts to hydrochloric acid", which the students had already been taught in the 6th grade of elementary school. There was not big difference between the percentage of correct answer of the experiment group (76.5%) and that of the control group (73.1%) after the lesson while the percentage of correct answer of the experiment group (44.4%) was lower than that of the control group (55.1%) before the lesson. The second question as an advanced task given only after the lesson was to represent a change: "Alcohol (ethanol) is made from grape (glucose)". The percentage of correct answer of the experiment group (19.1%) was higher than that of the control group (10.3%). The third question as another advanced task given only after the lesson was to represent a change: "Vinegar (acetic acid) is made by oxidation of alcohol (ethanol)". The percentage of correct answer of the experiment group (74.8%) was higher than that of the control group (65.4%). The evaluation suggests that the instructional program with greater emphasis of atoms' combination provides more fruitful learning for students to form a proper conception in chemistry.

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CONSTRUCTION OF ELABORATION CURRICULUM OF ADVANCED ORGANIC CHEMISTRY

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"Advanced Organic chemistry" is a required basic course to chemistry specialized senior students, with a 48 hr teaching period. In this paper, the advanced organic chemistry curriculum's construction, content and method are reported. The curriculum including the personnel research idea, the seminar, the laboratory work and the scientific research achievement, makes the students engaged in the exploration and the scientific research pleasure via the class discussion. The students are required to read the latest scientific literatures to broaden the knowledge of chemistry and understand the most recent developments in international organic chemistry. Through the class instruction and laboratory practice, the students are strengthened on the innovation ability and problem-solving ability.

1. Strengthening the curriculum basic contents, i.e. the problems of structure and the reactivity; the reaction mechanism; the solvent effect; the controlling of kinetics and thermodynamics and so on.

2. Organizing the students to deliberate some public topics and discuss some chemistry survey, for instance, about "2011 Noble chemistry prize - quasicrystal discovery", "the cooking oil with deleterious substance", "the physical effect of Vitamin C", "the acidity of ionic liquid" and so on.

3. Introducing two topics in free radical chemistry. One is "free radical biology-oxidation resistance and disease" related with life sciences; the other is "ATRP for assembly graphic nanomaterial" related with material science .

4. The combination of this curriculum and student's laboratory study has resulted in researchful organic synthesis experiment-"Study on the synthesis and identification of Coumarin". Through the process of the choice of synthetic methods, purification of crude products, determination of structure by IR, NMR and MS, and a final discussion of the relationships between mechanism-synthetic route and structure-reactivity, the goal is to better and further raise the students' spirit of innovation ability and studies assiduously.

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THE CONNECTION OF ACADEMIC ENGLISH PROFICIENCY

AND THE SCIENTIFIC ACHIEVEMENT IN COLLEGE STUDENTS MAJORED IN SCIENCE SUBDIVISIONS

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As the formation of the global and knowledge-based economics, English proficiency is emerged as an index to determine the competitiveness of a country in the 21st century. In theory, students acquire two different kinds of English proficiency from their educational process: one is for social and interpersonal communication, and the other is for professional and academic development. In Taiwan, the English education system from the beginning to the high school level is more emphasized on the social communication skills, and students always face a culture shock when they enter the college, especially for students majored in the science subdivisions. The majority of the teaching materials provided are written in the academic English. However, very little research has been done to examine if the students are equipped with enough proficiency to comprehend their subject materials, not to mention the relationship between the academic English proficiency and their science achievement. In this study, we collected and analyzed the grades of English related academic tests and the general academic performance of the students major in chemical biology and applied physics in National Pingtung University of Education. We found that the English proficiency is positively correlated with general academic performance when students are majored in chemical biology but no apparent correlation if they are in physics. These results can be used as an index to evaluate the career plan of the students and help instructors in designing teaching strategies.

THE FORMATION OF PROFESSIONAL COMPETENCE OF THE ENGINEER-CHEMIST WITH THE PARTICIPATION OF EMPLOYERS

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The professional activity of chemical-technological profile specialists is becoming increasingly multi-functional and polysubject. In the conditions of modern production engineer-chemist need to know the environmental guidelines, consumer demand, efficiency, marketing, copyright and other to solve problems connected with missing and redundant data, with a high degree of uncertainty and risk. The engineering is becoming one of the most important on the degree of influence on the society development, and engineering-technological education - the leading factor of social and economic development and powerful intellectual and spiritual resources of any state.

United Nations Educational Scientific and Cultural Organization (UNESCO) with the participation of Europian Federation of National Engineering Associations and Accreditation Board for Engineering and Technology (USA) developed requirements to the engineer of the 21^{st} century which include: a high level of professional competence; aspiration to continuous personal and professional improvement and development of their intellectual capacity; be competent in the methods of modeling, forecasting and planning, as well as the methods of research for the creation of new intellectual and material values.

However, according to employer's surveys about the quality and the level of graduate's education, working for their company, young specialists have a good level of theoretical training, but often can not apply the received knowledge in practice. In addition to chemical engineers of the lack of economic knowledge, free of foreign languages and a wide mental outlook.

There is a problem of inconsistency with needs of production and the readiness of young specialists for professional activities. This means that in the formation of engineers of any profile it is necessary to apply the competence-based approach. Education should be built in accordance educational and professional standards. Representatives of the industry, the business community should be participate in the formation of educational standards, so as soon as employers can formulate the most actual and necessary requirements for the professional education of young specialists.

THE ROLE OF SUPPLEMENTARY EDUCATION IN CAREER DEVELOPMENT

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The efficiency of every organization unit and organization in general depends on staff (especially managerial staff) qualification. Social researches in various fields of activity show, that over last years 30-40% of acting leaders hold a position without special education. Most of them compensate missing attainments at various extension and refresher courses, in-company trainings and open workshops.

The necessity of supplementary education is determined by criterions and requirements for heads and candidates looking for relevant leader position. For example, engineers of various categories, having practical industrial experience and a great mind of upward move in career, need managerial knowledge and skills. On another hand, certificated managers need knowledge concerned with special features of production (f.e. chemical technology). Skills from adjacent branches of knowledge and competence of their usage play the important role in professional and career development of every employee on any personnel position in different sectors of economic activity.

Limiting factor of personnel career development is headman's interest and necessity in professional staff. Supplementary professional education may be the instrument for improvement of higher professional education quality as well as effective mechanism of personnel advance and development.

Besides, the development of National Qualification System will allow at the time of university education to select and take the supplementary (to the main educational program) knowledge, necessary for the successful launch in chosen career path. In accordance with the above mentioned approach the difference between employer requirements and attainment level of graduates will be eliminated.

DEVELOPMENT OF TEACHING MATERIAL BASED ON COMPUTER GRAPHICS BY QUANTUM CHEMISTRY CALCULATION - NITRATION OF BENZENE -

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Visualization of computer graphics (CG) gives us great help to realize images not only of molecular properties but also of molecular behavior on dynamical reaction mechanism. It is our aim to produce CG teaching material (CG-TM), which provides realizable images of the nature of chemical reaction. Nitration of benzene is one of typical reactions in organic chemistry, and the reaction is often adopted in TM on the curriculum of high school and the university, including many appropriate schemes.[1] The scheme should be developed for student to acquire more realizable images of the nature of the reaction. We developed CG-TM of the reaction including change of the structure of reactants for university student.

Nitration of benzene proceeds via π-complex and σ-complex as intermediates,[2] and overall reaction is controlled by those intermediates. In this work, one of the controlling reactions, the σ-complex, with structural change was treated by the calculation with MOPAC/PM5. Structures of Transition states were verified by the observation of a single absorption peak in the imaginary region by the vibrational analysis. Ea in vacuum was 115 kJ mol-1, which was slightly higher than the experimental value[3] of 92 kJ mol-1 in solvent. Furthermore, bond length, R, of the final product, Nitrobenzene, was in good agreement with reported value[4] in parentheses, for example, R_{CN} = 1.492 (1.467) Å and R_{NO} = 1.220 (1.220) Å. Reaction paths around the σ-complex were calculated by the IRC method and the Quick Time movie files were produced. The CG-TM could demonstrate the structural change of reactants with both space filling and ball-and-stick models along with the reaction profile, which can provide image of energy change during the reaction (Fig. 1). The CG-TM can be loaded with Note-PC, tablet computer, and smart phone.

Practice to the university student was conducted. Surveys revealed that the CG-TM in tablet was moderately effective to provide information concerning changes of structure.

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VISUALIZATION OF CHEMICAL REACTION BASED ON QUANTUM CALCULATION - ADDITION OF HALOGENS TO CYCLOPENTENE -

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We have developed a teaching material concerned about chemical reactions based on quantum calculation. This presentation demonstrates a visualization of the chemical reaction of halogenations. The reaction of olefin as like ethylene or cyclopentene is one of popular reactions in organic synthesis [1], and then the teaching material of the reaction was made for student to understand and realize the nature of the chemical reaction. Quantum calculation by B3LYP/LanL2DZ level was adopted for the reaction of cyclopentene. The calculation revealed the nature of halogenations that the reaction with halogen radical via homolytic dissociation of halogen molecule preferred comparing with that with halogen ions via heterolytic dissociation of halogen molecule in a gas-phase with Cl2, Br2, and I2. The results obtained by the calculation were visualized. Example of the visualization is shown in the figure which demonstrates the geometries of atoms on molecular structures and potential energies of reactants, intermediate compounds, and products. The lesson which utilized the visualization was carried out in an undergraduate physical chemistry laboratory class of junior (third year) level students of teacher's college, Tokyo Gakugei University (TGU) in the period of spring semester in 2011. The result of students' attitudes and the questionnaire to the students suggested that students have realized somewhat smoothly the nature of halogenations, and answers to the questionnaire overall revealed that a way of the lesson was one of the influential methodologies for enhancing student's understanding and realization of the nature of the chemical reaction.

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EVALUATING THE DEVELOPMENT OF NONSCIENCE MAJOR STUDENTS' MOTIVATION FOR LEARNING CHEMISTRY AND ITS INFLUENCE ON THEIR ACHIEVEMENT

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It is well known that learning in general, and also in chemistry is a complex mental phenomenon in which motivation is one of the key variables. Motivation and learning processes are linked with academic results[1]. Motivation, together with cognition, is a key component and the two are inseparable and necessary in the quest to understand learners' behaviour[2]. Pintrich and Schrauben[3] seem to share the same views in their socio-cognitive model of learning motivation. According to this theory, the individual's participation in the learning process is conditioned by the interaction of motivational and cognitive elements. In the self-determination theory[4] external activities should be designed in such a way that students value and self-regulate their participation in these activities without external pressure. Human motivation requires a consideration of innate psychological needs for competence, autonomy, and relatedness. This theory focuses on the degree to which human behaviors are self-determined.

The main research problem refers to the shift of motivation from extrinsic to intrinsic during a one-semester non-science majors' chemistry course and which variables (e.g. chemistry achievement, formal reasoning abilities, teaching approach, students' responses to questions in class) affect this process.

Thirty-six non-science majors participated in the study. A mixed method research approach was used. A 25-item 7-point Likert scale "Reasons for Leaning Chemistry" questionnaire (RLCQ)5 questionnaire, Group Assessment of Logical Thinking (GALT) test (12-item paper-pencil Piagetian test), achievements scores, semi-structured interviews, and classroom observations (teaching pedagogies used) were used in the study.

Results of this study will be presented.

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INTERACTIVE AND TOPICAL CHEMISTRY FOR UNIVERSITY FRESHMEN

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Development of topical and motivating chemistry education has been strived for a long time. The traditional advancements have involved curriculum changes, development of new laboratory exercises and learning environment, and modernisation of course contents, and teaching and learning methods. On the other hand, still large lecture courses with hundreds of students are given continuously. One of the motivating aspects seem to have been missed over the years and during the various development stages: How well are the basic chemistry courses for university freshmen -coming from various disciplines and study topics – connected with everyday life and modern scientific findings and discoveries.

At the University of Jyväskylä, a start-up course for chemistry majors have been introduced, lecture courses have been connected with laboratory courses and their content have been mutually adjusted, teaching methods and learning environments have been developed and educational training of first year university teachers have been stepped up vigorously. Another piece in the development puzzle was added in autumn 2011, when a new course running parallel with basic chemistry courses and laboratory exercises was introduced. The course, Chemistry of the living environment, with 248 enrolled students, was built on topics together with the students on the first meeting. The only restriction of the topics was that they belong to the five categories predetermined for the course: air, earth, water, energy, and life. Moreover, together with educational researchers, the course was developed as one of the University level pilot projects on interactivity in education. The target was to develop a motivating course with a high level interaction both in teaching and learning. Preliminary results from education research measuring the success of interaction upon learning and motivation seems to be very encouraging for further development of the course and the interactive learning atmosphere adopted.

In this presentation, we will discuss the content of the course, how the course was developed and present research results of the questionnaire-based research project realised during the course.

A NEW APPROACH TO QUANTUM CHEMISTRY IN A GENERAL CHEMISTRY CLASS

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The current model of atomic orbital is closely tied to understanding the quantization of energy and how this energy can be explained in a space. This issue is very complex to students fresh out of high school. The textbooks now used combine two concepts: the concept of stationary wave atomic model and the concept of particle atomic model[1,2.] Here we show a model that presents quantization of energy as the result of stationary waves. We also show common stationary waves and their behavior.

The present atomic model can be described as three dimensional model of wave stationary model[3]. The radial nodal regions can describe the Principal Quantum Number (n) that can also be associated with the size of the atomic orbital. The angular nodal regions will show the shapes of the orbital that are described by the azimuthal quantum number quantum number or secondary. The teacher, as mentor, shows that the nodal angles are planes to cut the ball, and they are orthogonal. So there may be up to three of these regions. This can be exemplified by a balloon, the kind used in birthday parties for children, which can be filled and folded every time one passes through the nodal region. The student can then describe the orbital s with no angular nodal region (no planes), the orbital p with a angular nodal region (a plane), the orbital d (two angular nodal region (two perpendicular planes), and finally, the orbital f with three angular nodal region (three perpendicular planes). The Magnetic Quantum Number Orbital represents such a possibility of orientations. In taking up the orbital with their forms, the question arises: how many orbitals can be placed in the same space without an overlap of orbital? What are the different possibilities of orientation of a orbital in space? The answers shall be given for the orbital of the type s, p, d or f which are one, three, five and seven respectively. The fourth is the Spin Quantum Number, which in this model can be defined as the time it began to vibrate, ie anti-symmetric functions. This quantum number can have only two possibilities.

The result of applying this model can be seen in the students' understanding of the chemical bond, in the use of software for calculating properties of molecules and in materials science classes. Besides understanding the reaction of molecules used in other disciplines. Students with these skills are best developed in other disciplines.

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STUDY OF MISCIBILITY OF LIQUID MIXTURES WITH A CRITICAL POINT

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This paper describes a new experiment for undergraduate students in physical chemistry. This experiment describes a separation process of liquid-liquid extraction using mixtures with a critical point of miscibility. In this experiment students will learn how to measure solute concentration, how to determine a phase diagram, and a new liquid-liquid extraction technique. In this experiment, a liquid mixture, together with the solute to be separated, is first heated above its critical temperature, where it forms a uniform solution, and then cooled to the region below the miscibility curve, where it separates. Students will understand that this separation process has the advantage that the resulting separation of the solvents is very rapid, even in the presence of emulsion-forming impurities. In addition, the extraction efficiency of it may be 10 times higher than that of the traditional liquid-liquid extraction. The new process is thought of having significant advantages in the extraction of products from fermentation broths, plants, and other natural sources.

Objective: Miscibility of binary liquid mixtures of methanol-cyclohexane and acetonitrile-water-toluene will be studied. A two-phase distribution ratio will be determined. Temperature and composition of the liquid-liquid critical point will be determined.

THE ANALYSIS OF TEACHING CONTENT AND TEACHING OBJECTIVES DESIGN BASED ON THE CORE CONCEPT OF EDUCATION

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This paper analyzes the deficiencies about teaching objectives design of high school chemistry education. From the perspective of improving the teaching quality, the author proposed the basic ideas about teaching content and teaching objectives design based on the core concept of education. Firstly, the relevant requirements of curriculum standards should be analyzed. Secondly, the specific materials and the main body of knowledge should be analyzed. Thirdly, the original cognitive understanding and the follow-up cognitive understanding should be analyzed. Fourthly, the core concept of chemistry ideas and methods should be analyzed. With two examples, the author elaborated the basic idea on the operation mode and practical value, expecting to give inspiration to the younger counterparts.

Key words: *The Core Concept of Teaching Chemistry; Teaching Objectives; Teaching Content; Description of Teaching Objectives.*

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WHAT CHANGES AND WHAT REMAINS? DIDACTICS SEQUENCE FOR THE TOPIC OF CHEMICAL REACTION

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In this paper we consider the chemical reaction as the central axis of this discipline. An activity is presented. To provide the teachers that taught chemistry at the college degree, information and suggestions of sequenced activities are provide that included suggestions to lead their students to the development of its own models of chemical reaction, as well as bringing closer them to the scientific point of view of this concept.

We believe that to have better understanding of what happens when a chemical reaction occur, the teachers should include gradual explanations to phenomenological, symbolic and nanoscopic level; and it is not enough that students perform experiments whose analysis involved only writing and balancing chemical equations, carry out stoichiometric calculations or classifying chemical reactions.

We propose a sequence of activities that begin with an analysis of chemical changes known by students, follow with an analysis of some properties of products and reagents involved in several specific chemical reactions and ended up modeling chemical changes using the molecular kinetic model.

Activities are sequenced in such way that complies with the achievement of the expected learning, this is to understand the essence of the chemical reaction concept. Therefore, the first activity aims to reflect on the difficulty of distinguishing between physical and chemical change. The second activity intend to show that the products obtain in a chemical reaction have properties different than the initials substances. The third activity emphasize on conservation of mass in a chemical change. Both the second and the third activities also seeks students recognize that there are three levels of representation (phenomenological, symbolic and nanoscopic level) and therefore of explanation for the chemical phenomena. Activity five emphasize on the symbolic representation of the reactions and a method for balancing them and at the same time to fulfill the law of conservation of matter.

This sequence was already tested with students of college level and the results obtained in one of the activities carried out.

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EXPERIENCED TEACHER´ PEDAGOGICAL CONTENT KNOWLEDGE IN A GENERAL CHEMISTRY COURSE

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In recent years, researchers have shown a growing interest in the study of pedagogical content knowledge (PCK), since its inception as teacher-specific professional knowledge. Many studies in the literature have addressed this knowledge and it has been embraced by many of the recent educational reform documents as a way of describing the knowledge possessed by expert teachers. This study investigated the PCK of an experienced chemistry teacher during one semester in a general chemistry course. This teacher works about thirty years at the undergraduate level and has a historic of good performance as a teacher, considering the periodic assessments conducted by his students and also the opinion of colleagues. The main aim of this study was to identify the teacher´s PCK elements from existing practice in the classroom. A case study approach and qualitative analyses was designed and the collection of data involved videotape recording of classes and interviews with teacher. We then analyzed the data focusing on the factors contributing to the development of elements of PCK, according to model for science teaching proposed by Magnusson et al.[1]. From the observation of videotape recording it is clear that teacher´ subject matter knowledge is good, which was evidenced by detailed approach of important aspects of the contents taught. Considering the components of PCK for science teaching1, the teacher presents a high degree development for most of them, which we cite: knowledge of science curricular, knowledge of students´ understanding of science, knowledge of instructional strategies and orientation to teaching science. According to the different components of orientations to teaching science, we found that the teacher shows the orientations: process, academic rigor, didactic and conceptual change. From the interviews we found that she considers her classes as strongly expository and recognizes that the ideal situation would be one in which students are involved in investigation solutions to authentic problems, which reflects the orientation "project-based science". However, attributes not to perform this procedure due to the need for a more sophisticated planning that fits in to the short time available in the evening course and profile of students. Although it has a development of various components for science teaching science in their practice, the teacher still cannot modify her expository classes, which suggests the need to develop this component of their PCK.

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SELF-DIRECTED LEARNING IN HIGH SCHOOL CHEMISTRY CLASSES: A CASE STUDY FROM MAINLAND CHINA

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Self-directed learning is beneficial to students' lifelong learning and sustainable progresses. It has been recently emphasized by the chemistry curricular standards of high school in Mainland China. Also, self-directed learning has drawn much attention from science educators, and it has become one of the most important topics in today's educational reform.

This case study aims to investigate several practical issues related to self-directed learning in chemistry classroom. These issues included the level of independence, the teaching approaches, and the classroom context. Participants were three experienced high school chemistry teachers from three different localities in China. Each of them was invited to organize a self-directed chemistry class that focused on the properties of silicon. Grounded on previous literatures of independent learning, we developed a theoretical framework that focused mainly on four aspects: including learning motivations, ways of facilitating self-directed learning, timelines, and the classroom context. This framework was then used to evaluate and compare the effectiveness of the three chemistry classes.

Three main findings were identified, and they indicated that the benefits of self-directed learning were not necessarily guaranteed. First, students' motivation is an important prerequisite for their self-directed learning. Second, students' active engagement in inquiry-oriented experiments played a key role in their self-directed learning. Third, the teacher's effective in-situ scaffold was another essential factor that facilitates students' self-directed learning.

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THE MODELING OF INSTRUCTIONAL STRUCTURE IN THE TEACHING OF CHEMICAL THEORIES - A STUDY BASED ON CLASSROOM INSTRUCTION VIDEO CASES[13]

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Since the 1990s, in the international assessment programs of mathematics and science education (such as TIMSS and PISA), the participating countries use classroom instruction video cases as a new strategy to study the relationship between classroom teaching and students' academic achievement and development of personal qualities. Researchers have developed some video coding analysis techniques and software tools, which help them locate problems in instruction in order to find improvement solutions. In China, the modularization of elective teaching materials has been implemented in the new chemistry curriculum and therefore, modeling of instructional structure is needed to understand the composition and patterns of classroom instruction. Thus the study of classroom instruction video cases is becoming a focus of attention in chemistry education.

The study explored the collecting methods of classroom instruction video cases and discussed the analysis dimensions of instructional structure. By selecting 9 outstanding chemistry instruction video cases (including 6 chemistry theory teaching cases and 3 element compound teaching cases) and using the Videograph analysis software, the author analyzes and compared these cases from three major dimensions: students' learning behaviors, teachers' teaching behaviors and the teacher-student interactions.

Seven parts of the video cases were coded: teacher's introduction, teacher's new content instruction (enlightening instruction and direct knowledge instruction), teacher and students' inquiry (teacher's experiment demonstration and students' self-exploration), teacher and students' discussion (students' group discussion and teacher-student discussion), lesson drills, lesson summary, and other instructional activities.

In the study, time data of the seven parts were coded using Videograph. The common and unique instructional elements across the video cases were summarized. Then a comparison between the 6 theory teaching cases and the 3 element compound teaching cases was made to reach a model of chemical theory instruction structure. The author presented a theoretical illumination of the model and wanted to share the model with chemistry teachers, so that the inquiry-based teaching method can be applied for more efficient classroom instruction.

Key Words: Instruction video case, Coding analysis, Chemical theory teaching, Instructional structure modeling.

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TOPOLOGY IN CHEMISTRY – CAN IT BE EXPLAINED IN SIMPLE TERMS?

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In the last decades, the applications of the highly abstract mathematical discipline topology have grown in importance for understanding chemical structures. One of the best known examples is the emergence of the term *topological chirality*, used to describe a strong notion of chirality – an object is topologically chiral if it retains chirality even under continuous deformations.[1,2,3,4] Because of the complexity of the subject matter, such topics are almost completely evaded during chemistry education. The authors wish to present a choice of applications[5,6,7,8] of topology (topological chirality, knot theory, chemical graph theory, topologically interesting molecules) suitable to be used in secondary or tertiary chemistry education, with explanations that are both mathematically and chemically sound and appropriate for the described education levels.

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USING RESEARCH ON CFC REPLACEMENT COMPOUNDS TO UNCOVER IMPLICIT ASSUMPTIONS OF LEARNERS ABOUT BENEFITS, COSTS AND RISKS IN CHEMICAL DESIGN

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One of the most important thinking processes relied upon by chemists is weighing the benefits, costs and risks (BCR) in the design of chemical products. Preparing students to be chemists who are equipped to work in the modern chemical industry requires educating students to reason strategically about BCR. We believe that the development of learning progressions in this area could help us support such educational efforts. A learning progression is a description of potential pathways by which students advance in understanding and ability to apply core ideas over an extended period of time. We contend that such a progression can be characterized by identifying changes in the implicit assumptions[1] that students make about BCR in the context of chemical design. To illustrate this idea, we present initial results for the characterization of a hypothetical learning progression for BCR in chemical design using research in chlorofluorocarbon (CFC) replacement compounds as a contextual issue for exploring student reasoning. Using an initial set of implicit assumptions about BCR derived from systematic review and analysis of existing research on individuals' conceptions about BCR in diverse contexts, an interview protocol was developed to probe whether these assumptions actually emerged when applying BCR thinking to chemical design problems. For example, laypersons have been shown to rely on their inherent value systems when asked to assess high- or low-risk situations.[2] Although students may suspend their value systems when working on traditional chemistry textbook exercises, such value systems may come into play when challenged to solve chemical design problems in realistic contexts. To explore these ideas, interviews are being conducted with undergraduate chemistry students at different levels in their training to uncover BCR reasoning while analyzing a realistic scenario: Atmospheric chemistry of CFCs and related refrigerants, propellants, and industrial cleaning agents. This scenario serves as a context for generative interview questions designed to uncover students' mental models and underlying implicit assumptions. These data permit the construction of a hypothetical learning progression that describes likely pathways in the development of more sophisticated BCR reasoning in the context of chemical design.

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THE IMPACT OF GUIDED-INQUIRY METHODS ON DEVELOPINGUNDERSTANDING OF THE MATTER CONCEPT

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The purpose of our current study was to review students' perceptions and understanding of the properties of matter. The study was performed in four classes at the 7th grade level (ages 13–14): two of the classes were taught by teachers using guided-inquiry instruction and the others by teachers using the traditional approach. A guided-inquiry based approach at the macroscopic level has been used similar to the American National Academy of Sciences' National Science Resources Center's curricula, (STC).

Three methods of analysis were used: the knowledge gained was measured from the percent of correct answers on pre- and posttests on multiple-choice questions (with and without explanations) , the cognitive structure of the knowledge was determined using the knowledge space theory (KST) developed by Doignon and Falmagne (1999) and others (Taagepera, M. et al., 2005), and the answers were analyzed for misconceptions.

The challenge of presenting the macroscopic, submicroscopic and symbolic levels of chemical knowledge seems to be alleviated by first providing a working knowledge of the main concepts at the macroscopic level using a guided-inquiry based approach and then building on this at the submicroscopic and symbolic levels.

The explanations were carefully analyzed, since it has been observed previously that students give correct answers without necessarily being able to justify why the answer was correct (Vaarik, A. et al., 2008). If students cannot explain why the answer is correct, then the students probably do not understand the concept and we are getting false positive results.

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CHALLENGES OF IMPLEMENTATION ON THE CHEMISTRY-PROJECT-BASED LEARNING IN HIGH SCHOOL AND COUNTERMEASURES

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In the different stages of implementation on the chemistry-project-based learning, students and teachers encounter various difficulties. The paper analyzes the challenges which students encounter in the process of chemistry-project-based learning, and introduce some countermeasures in the form of cases, for example, how to help students choose the suitable topic of project-based learning, how to keep the learning motives of students, how to manage students' own inquiry activities. The paper also analyzes the difficulties which teachers encounter in the implementation, and find out the key to the solution is to get the balance among teachers' instruction, students' inquiry activities, and the management of school.

Key words: Chemistry-project-based Learning; Challenge; Countermeasure.

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APPLYING THE EMPOWERMENT EVALUATION TO OPEN INQUIRY ACTIVITIES

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Seoul National University's Gifted Education Center held the open inquiry activities that students chose the research theme by themselves and conducted their own research. In this study, we applied the method of empowerment evaluation meaning that students evaluated and criticized their classmates' open inquiry activities and discussed how to improve. The program was designed in three steps: 'present and evaluate the research theme', 'present and evaluate the research design', 'present and evaluate the result'. Through the program, all students presented their own research and participated in empowerment evaluation. The results are as follows: Gifted students have shown the tendencies to apply severe criteria in their evaluation and acidly comment to the hard working student. However, the result of the empowerment evaluation conducted by themselves was found out to be equal to the teachers' evaluation result. Most of the students said that having the opportunity to evaluate their classmates' presentation stimulated their scientific inquiry skills, and we found that some students tried to apply other students' methods to improve the procedure of their own research. Moreover, during the evaluation process of other teams' research results, gifted students seemed to be clear and accurate to the concept of variance. Even though all of the students showed positive attitude toward this program, many students expressed that they felt pressure to do better, and one of the student cried when other gifted student pointed out the problem in her experimental design. We tried to analyze the phenomena in view of the characteristics of gifted students.

A CASE ANALYSIS OF MOTIVATION AND STRATEGY FOR INQUIRY PROCESS

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Goal of science education is to achieve scientific literacy. So students' understnading of the nature of science and scienific inquiry is important. Inquiry helps students to learn scientific thinking through providing opportunities to acquire nature of science (NOS) and scientific content knowledge.[1] One of the goals of science teacher education is to prepare pre-service teachers to teach science as inquiry supported by constructivist learning theory.[2] In this study we investigate pre-service teachers' motivation and strategy of generating inquiry question to provide meaningful methods which help pre-service teachers to generate inquiry question or hypothesis by themselves.

Participants performed one subject of inquiry for 4 weeks and were responsible for hypothesis, data collection, and interpretation. After inquiry program finished, researchers choose a case group by peer-review and discussion with 2 teaching assistants. About this group, we analyzed features distinguishing them from other groups based on reports, questionnaires, and recorded interview. In case of this group, they made three strategies from first question and two motivations (Figure 1). The features of motivation are recognition of important variation (M1) and practical use of peer-discussion (M2). First, they changed experimental design after notice about the most important variation for purpose of experiment. So they could concentrate on what they should to do in each step of inquiry. Second, they developed a hypothesis of experiment and made a strategy for hypothesis. They wanted to make a new knowledge for school science after having a peer-discussion. From this investigation we found that among various factors, recognition of variation suitable for purpose and practical application of discussion are important factors for meaningful inquiry.

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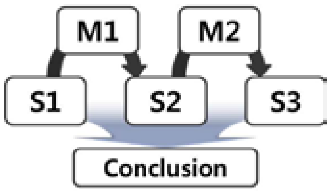

Figure 1. Process of detailed strategies(S#) and motivations(M#) during inquiry.

WHAT INDICATORS ARE APPROPRIATE FOR DIFFERENTIAL ACID–BASE TITRATIONS? INCORPORATING DISCOVERY LEARNING INTO GENERAL CHEMISTRY LABORATORY

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The purpose of this study is to guide freshmen students through discovery learning to find appropriate binary indicators for differential acid–base titrations [1-4]. As a binary-mixture solution of sodium hydroxide and sodium carbonate was titrated with hydrochloric acid, three equivalence points appear in the completions of three reactions of sodium hydroxide, sodium carbonate and sodium bicarbonate with the acid. In this discovery learning, the students were encouraged to discover appropriate binary indicators at second and third endpoints of the titration. To solve a problem that the students were difficult to merely apply titration curves to accurately determine the equivalence points, the students needed to learn the derivative endpoint methods. In this study, the students completed this learning during two three-hour laboratory sessions. The process outlines in Week I contained introducing differential titrations, learning derivative methods, carrying out a pH titration, creating a titration curve and derivative graphs, determining endpoints by derivative methods, and choosing feasible indicators listed on the Internet. The outlines in Week II included using real indicators provided in the lab, carrying out titrations using chosen indicators, evaluating feasibility for chosen indicators by percent error, finding out appropriate indicators, sharing evaluative results with the whole class. The students found that six pairs of appropriate binary indicators are appropriate at second and third endpoints for the differential acid–base titration: thymol blue and methyl red, thymol blue and methyl orange, thymol blue and Congo red, phenolphthalein and methyl red, phenolphthalein and methyl orange, as well as phenolphthalein and Congo red. The students not only acquired derivative endpoint methods but also had positive responses in their feedback for this discovery learning. This study also found that using derivative endpoint methods and feasible evaluation methods to find appropriate acid–base indicators were effective processes and methods for general chemistry laboratory students.

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DYNAMIC PROBLEM-BASED LEARNING IN CHEMISTRY

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Problem-based learning (PBL) is becoming increasingly popular in chemistry education at the third phase. PBL has been demonstrated to deliver enhanced understanding, greater retention of knowledge and effective development of transferable skills. PBL activities are based around real-life scenarios. Dynamic problem-based learning (dPBL) attempts to make the problem scenarios more 'real' by introducing dynamic elements. The dynamic elements may involve student choice in scenario, introduction of differing data sets or the introduction of external changes to the context. Our dynamic PBL activities use sustainable development as a context and attempt to include elements of globalisation. Students are engaged in designing a sustainable community and have to consider aspects such as power needs and generation and waste management. The dynamic elements are implemented in several ways. First, the students have a choice of one from four scenarios; development of a microgeneration community in an area of outstanding natural beauty in the US, design of a postgraduate research campus in Hong Kong, greening a University campus in the UK, or the provision of ecologically sustainable public transport running on biofuels. Another dynamic element is introduced in the student selection of a team of virtual experts to provide additional data. Throughout the activity, which runs over several sessions, the dynamic aspect of the PBL is enhanced by providing the students with events which impact on their decision making processes. For example, their budget may be cut, the political agenda may change, or they may lose key staff. In this way, each group of students essentially solves a different problem. There can clearly be no 'correct' answer and the best outcome depends to a great extent on the context in which they are solving the problem, thus mirroring real problem solving. The details of the activities and outcomes in terms of students learning and skills development will be discussed.

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DEWEY TO MCKEON TO SCHWAB: INTELLECTUAL ORIGINS OF INQUIRY IN EDUCATION

Donald Wink

The concept of inquiry and student-centered instruction is a powerful and recent phenomenon in education. It is important that those who would practice this kind of instruction understand how these arose, both to strengthen their own work with better intellectual foundations and to address those who believe that instruction in the practices of science is unimportant or even damaging in science education. This talk reviews the role that John Dewey played in this effort, directly through his own writings and through his influence on others who were more active in science education. Dewy's role in the development of 'meaning-centered' education in the work of philosopher Richard McKeon and McKeon's subsequent influence on the science educator Joseph Schwab will be presented. Articulation of these ideas with the US's new Next Generation Standards in Science will be reviewed also.

PRE-SERVICE PRIMARY SCHOOL TEACHER PRACTICE OF MATHEMATICS IN OPERATIONAL CHEMISTRY AND PHYSICS PROBLEMS AND MATHEMATICS SELF-EFFICACY PERCEPTION

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Science education uses problem solving as a method for teaching basic fields; physics, chemistry and biology. Instruction in science is generally aimed at achieving two goals: the acquisition of a body of organized knowledge in a particular domain and the ability to solve problems in that domain. An individual with advanced problem solving skills can effectively use knowledge and can easily solve the problems encountered [1]. One of the most important reasons of students' failures in problem solving is calculation based problems. Students' attitudes, self-efficacy and motivation are variables which play an important role in this type problem solving [2].
The aims of this research are; to define Mathematics usage inclinations and Mathematics self-efficacy perception, to evaluate them in terms of various socio-demographic varieties, to study the connections between Mathematics usage inclinations and Mathematics self-efficacy perception in Operational Chemistry and Physics Problems predicating the study on Pre-service teachers. Research model is relational screening. The population of this study is formed by pre-service science teachers, classroom teachers and gifted education teachers taking "General Chemistry" and "General Physics" at Faculty of Education. Mathematics usage scale in Operational Chemistry and Physics Problems (MUSOPCP) has been developed by researcher and Mathematics Self-Efficacy Perception Scale (MSEPS) has been developed by Umay (2000) were used as data collection instruments [3]. SPSS 16.00 is used to analyze the data. ANOVA, independent T-Test has been conducted to monitor the scores taken from the scale in terms of socio-demographic varieties. PEARSON correlation coefficient analysis technique is applied in order to observe the relations between Mathematics usage inclinations of pre-services in Operational Chemistry and Physics Problems and Mathematics self-efficacy perception. As a result of data analysis; Scores of scale factors was found to be statistically significant according to gender, academic department and the completed secondary education variances. However class group's arithmetic average difference has been found statistically no significant. The relations between scale factors scores have statistically significant.

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PÓLYA'S STRATEGIES FOR MATHEMATICAL PROBLEM SOLVING AND ORGANIC CHEMISTRY IUPAC NOMENCLATURE ATTRIBUTION: AN ANALOGY

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On his classic text, "How to solve it"[1], the hungarian mathematician offers something intellectually refined: a set of strategies for solving mathematical problems. He enumerates *mental operations typically useful for the solution of problems*1. What is needed to solve organic chemistry IUPAC nomenclature attribution? Knowledge and a good strategy to succeed .
Some of the operations stated by Pólya are as listed below[1:]

1- What is the unknown? Look at the unknown and try to think of a familiar problem having the same or a similar unknown

1- What are the data?

2- What are the conditions? Is there a condition linking the data?

3- Can we devise a plan to solve it? Where should I start? What can I do?

Many students when coming across with organic nomenclature problems usually think that it is only a question of memorizing rules. It is true, that is part of the basic knowledge to solve any problem. But when structures are more complicated Pólya's approach can be properly applied with many advantages for the intellectual and the development of an independent work. For instance, what structure corresponds to the IUPAC name of Eritromycin? 6-(4-(Dimethylamino)-3-hidroxy-6-methyltetrahydro-2*H*-pyran-2-yloxy)-14-ethyl-7,12,13-trihydroxy-4-(5-hydroxy-4-methoxy-4,6-dimethyltetrahydro-2*H*-pyran-2-yloxy)-3,5,7,9,11,13-hexamethyloxacyclotetradecane-2,10 dione?

1- What is the unknown? Where should I start? What is the basic structure? Where can I find it?

2- What are the data? Outside the basic structure what small parts of groups, that I have came across in minute structures, do I recognize? Do I find meaning on small suffixes like yl? Oxy? What information is transmitted when they are related and what if the information is escalated: 2-yloxy? In this work I would like to show that Pólya's approach offers a strategy for a dialogued resolution problem class, particularly when approaching more complicated structures and that it even softens the hardest part of organic nomenclature by assembling problem solving to an interesting puzzle resolution.

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APPROACHES OF ENGINEERING FACULTY STUDENTS TO SOLVING OF OPERATIONAL CHEMISTRY AND PHYSICS PROBLEMS

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General Chemistry and General Physics courses were taught in the first classes of the Engineering Faculties' all departments. Development of professional and mathematical information and skills used by engineering faculty students in solving operational problems plays a crucial role in the educational process. Much of the problem solving is quantitative, involving formulae and the application of mathematics, and is a source of great difficulty for many students. Many studies have been conducted on the problem solving models, the types of problems and successful problem solving [1-3].

The aim of this research is to define mathematics usage inclinations in operational chemistry and physics problems of students from Engineering Faculty. In this context, mathematics usage inclinations in operational chemistry and physics problems of students are defined and evaluated in terms of various socio-demographic varieties. This research model is relational screening model. The population of this study is formed by Chemistry, Chemical Engineering, Electrical-Electronics Engineering students taking "General Chemistry" and "General Physics". As data collecting instruments: "Mathematics usage scale in Operational Physics and Chemistry Problems" (MUSOPCP) which is developed by researcher is used. Following the factor analysis is noticeable that the scale is in two factor structure. These factors are defined as: 1. *Mathematics anxiety in Operational Chemistry and Physics Problems 2. Conceptual knowledge and Mathematics knowledge relation in Operational Chemistry and Physics Problems*. SPSS 16.00 is used to analyze the data. ANOVA, independent T-Test has been conducted to monitor the scores taken from the scale in terms of socio-demographic varieties. As a result of data analysis, the scores taken from the MUSOPCP's first and second factors differentiate between the arithmetic average according to the academic department variance; for the first factor has been found statistically significant but the difference is found out to be insignificant for the second factor. Electrical-Electronics Engineering students experience low mathematics anxiety while solving the operational chemistry and physics problems, chemistry students are conscious of the relation between the conceptual knowledge and mathematical knowledge in operational chemistry and physics problems. The scores taken from the factors according to the gender and graduated secondary school variance have not been found statistically significant.

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THE TEACHING-LEARNING SEQUENCE, AN IMPORTANT RESOURCE FOR CHEMISTRY UNDERSTANDING

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Chemistry has traditionally being a tough topic to teach and learn. The authors of this paper have taught this subject for many years, in courses of different academic levels, for undergraduate, graduate and professional development for in-service teachers. They have found how difficult it is to teach Chemistry to allow students to succeed in learning it; furthermore, they are quite convinced that teacher-learning sequences are a very important resource for teachers to improve understanding of Chemistry, as well as enjoyment of learning it.

We want to share our experience and, together with other colleagues from the Seminar of Research in Chemical Education of the Faculty of Chemistry (SIEQ, in Spanish), have designed several teaching-learning sequences (TLS) in central topics of Chemistry, considered particularly difficult for students of university level.

The structure of the designed TLS's are innovative because they cover a brief and updated conceptual synthesis of each subject and a didactic proposal that beginning from previous ideas or alternative conceptions of this scholar level students, clearly point out the learning demand; they also involve content pedagogical knowledge (CPK) of the theme, historical development of the main concepts, experimental demos, problem solving, analogies, exercises for individual and team work, assessment techniques and tools, and many references and didactic materials for teachers and students. It is important to mention that many of the activities are designed for classroom as well as on-line student's work

The aim of each designed TLS is to develop the competencies required to face nowadays education challenges. Among them Science, Technology and Society (STS) dimension, argumentation, inquiring, search an selection of information and team work have been included.

These TLS's have been designed by expert chemical educators and researchers; and they belong to the official curricular programs of General and Inorganic Chemistry courses. These TLS's have been probed with freshman and sophomore students of the Faculty of Chemistry of UNAM, and have been modified to fit curricular schedules and time requirements.

One example of TLS is given in this paper, it relates to chemical chemical bonding. The authors are working in other TLS's related to topics of higher courses.

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THE APPROACHES OF ELEMENTARY CLASS AND SCIENCE TEACHERS TO THE APPLICATIONS OF CHEMISTRY ACTIVITIES IN SCIENCE AND TECHNOLOGY TEXTBOOKS

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At the last decade, applied science teaching programs organized within the base of constructivist approach involve active attendance of students to the courses, and the methods and techniques that enable them to construct the new information in their minds [1]. During the education of Science and Technology; laboratory activities and other activities give them the chance to learn comprehensively and structure the science concepts practically [2]. The working methods, the principles and the findings of Chemistry, one of the sciences are applicable to daily life and that constitutes its general applicable quality [3].

This study aimed to define the opinions of Elementary Class teachers who conducted Science and Technology course in 4.th and 5.th grade and Science and Technology teachers regarding the activities which in chemistry field in the Science and Technology textbooks and to define the application level of these activities. As data collecting instrument tools, Activity Embracement Scale (AES) and Activity Application Scale (AAS), which are created by Özmen [4] and updated by Doğan [5] are used. Participants of this study are elementary class and science teachers. SPSS 16.00 is used to analyze the data and One-way ANOVA, independent t-test has been conducted to compare the scores taken from the scale in terms of socio-demographic variables and PEARSON correlation coefficient analysis technique is applied in order to find out whether the relations between scales' scores. According to results; there were no significant differences between AES score according the variables of gender, branch, seniority, graduation field. In addition, AAS score show that there were significant differences in terms of seniority and graduation field, while there were no significant differences according to gender and branch. It is also defined that there is a statistically positive and significantly correlation between the scale scores.

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DIFFICULTIES IN ORGANIC CHEMISTRY LEARNING AT UNIVERSITY

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Research and practice in chemical education in advanced courses are a new realm of study, and organic chemistry is a noteworthy component (1). Mechanistic explanation is a key topic for learning Organic Chemistry and it requires the knowledge of different specific representational systems. Particularly, the Electrophilic Aromatic Substitution (EAS) mechanism is explained by using resonances structures just because the intermediate is a resonance hybrid. In addition, to explain the product distribution of an EAS carried out on substituted benzene requires explaining why the intermediate of the faster transformation is lower in energy than the intermediate of the slower, competing transformation (2). The aim of the present work is to detect and analyse the main difficulties and the types of mistakes that students make when they solve different types of exercises/problems about EAS mechanism in a first course of Organic Chemistry. A sample of 236 students of Pharmacy and Biochemistry participated in this research. Four open paper-and-pencil tasks were designed with two questions complex enough for data gathering: 1) low order cognitive demand (LOCD), and 2) high order cognitive demand (HOCD). Both questions had two independent variables (reactant and substituent) in a 2x2 design (table 1). Answers were checked first with chemical criteria; then, the number and type of errors were analysed using qualitative and statistical approach. For all analysed examples students had difficulties (wrong answers: 38% and 77% for LOCD and HOCD, respectively). Main errors were: structures of intermediate (54.2%), the location of the new substituent (39.6%), nomenclature of the products (23.1%). Students usually require to rote memory to solve LOCD, but it is not enough to solve complex questions because of saturation of work memory and conceptual difficulties to reach an integrated view of Organic Chemistry network.

Table 1: Questions assessed

1) Which is (are) the product(s) of the following reaction? Draw the structure(s) and write down the name(s) of the compound(s):			
Anisole + Sulfonitric mixed acids	Anisole + Chlorine / Aluminium chloride	Acetophenone + Sulfonitric mixed acids	Acetophenone + Chlorine / Aluminium chloride
1) Detail using formulas the mechanism of the reaction of # 1.			

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USE OF BLOG *COL* AS A TOOL TO EVALUATE ACTIVITIES IN THE CHEMISTRY LABORATORY

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Introduction. The COL (orderly language understanding) blog (Andrade 2003), is one of the alternative assessment instruments used in a didactic proposal designed to improve the teaching of stoichiometry. The proposal consists of four experimental activities, three computer simulations, (Bransford et al 2000) stoichiometric calculation exercises and a series of exercises to promote skills in mathematical reasoning, representation of atoms, molecules, and chemical equations through models using symbols and applying the international color code to represent atoms.

The COL blog, ask the student to answer the following questions: what happened?, what I felt? and what I learned, and was used to evaluate experimental activities and simulations by personal computer.

Result. This instrument allowed us to know the student´s point of view related with the activities carried out, their emotions and feelings experienced during the execution of the activity, as well as, if it was to their liking or not. This instrument provides relevant information to continue or modify the development of future activities.

Conclusion. At the beginning, a large percentage of the students expressed a little anger and frustration, however, this feeling became joy and security once they understood the basis of the activity. Most of the students felt pleased with the achieved results and expressed the importance of the team work as support to clarify doubts and to advance in their learning. In addition to the advantages, mentioned with the COL blog, we led the student to make written reflections of the activity undertaken, becoming aware of the different aspects involved in the activity and becoming aware of their learning.

We present the results achieved by the students as well as their answers to the questions raised, expressed in their blogs.

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A STUDY OF CHINESE MAINLAND MIDDLE SCHOOL STUDENTS OF "ELECTROLYTE" CONCEPT DEVELOPMENTAL LEVEL AND ALTERNATIVE FRAMEWORKS

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The learning level of "electrolyte" conception has the profound influence for middle school student to understand and apply core knowledge about ionic reaction/ ionization balance directly. For the sake of understanding students learning level about "electrolyte" concept, we compiled diagnostic tool of «electrolyte» alternative frameworks according to two-tier test procedures, and was administered to 624 Chinese mainland students selected randomly from grade 9 to grade 12. The collected dates were processed and analyzed using Rasch model, and showed the differences and changes in all grades of students' alternative framework. Base on this we construct "electrolyte" framework for the students' development of this concept. Further not only classified students' alternative frameworks according to SOLO classification criteria, but through classroom observation and interviews of teachers and students, analyzed the causes of alternative framework in different stages of concept understanding development. Finally we provided specific recommendations for the teachers' scientific teaching.

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CRITICAL THINKING DISPOSITIONS AND ENTREPRENEURSHIP LEVELS OF CHEMISTRY AND CHEMICAL ENGINEERING STUDENTS

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Critical Thinking can be defined as an effective, organized and operative cognitive period enabling us to improve understanding our own thoughts and others ideas and our skill to explain the opinions [1]. Entrepreneurship is to create a value by engendering a novelty, using creative skills or by finding a new production, service, source, technology or markets in other ways [2]. In this context it can be seen that in entrepreneurship concept factors like: novelty, alteration, flexibility, dynamism, taking risks, creativity and focusing on improvement are affective [3].
The aims of research are; to define Critical Thinking Dispositions and Entrepreneurship levels, to evaluate them in terms of various socio-demographic varieties, to study the connections between Critical Thinking and Entrepreneurship of Chemistry and Chemical Engineering students from Engineering Faculty. The sample of the research is constituted by the senior students of Chemistry and Chemical Engineering Students. As data collecting instruments: The California Critical Thinking Disposition Inventory (CCTDI-R), which is improved by Facione, Facione and Giancarlo (1998) and adapted to Turkish by Kökdemir (2003) is used besides Entrepreneurship Scale (ES) which is developed by Yılmaz and Sünbül (2009) [4-6]. SPSS 16.00 is used to analyze the data. One-way ANOVA, independent T-Test has been conducted to monitor the scores taken from the scales in terms of socio-demographic varieties. PEARSON correlation coefficient analysis technique is applied in order to observe the relations between the scales. As a result of data analysis, the scores taken from some of the CCTDI-R factors are meaningful according to the gender and graduated secondary school variables but according to the department group it is visible that all of the factors are not meaningful. At the same time the scores taken form ES are not statistically meaningful regarding all variables. It has been defined that statistically among all factor scores of scales have positively meaningful relations.

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CHEMISTRY AND CHEMICAL ENGINEERING STUDENTS' SELF-EFFICACY LEVELS OF MATHEMATICAL LITERACY AND THEIR DISPOSITIONS OF CRITICAL THINKING

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Mathematical literacy is the ability to understand and recognize the role of mathematics in the surrounding environment by using mathematical thinking and deciding while facing the problems of the present and future as a thinking, producing and critic sizing individual [1]. Critical thinking is a positive analysis enabling us to comprehend the events happening around us. This system of analysis is a system that can be used for defining the problems, starting the studies of any aimed subject, deciding and making evaluations retrospectively [2]. The aims of this research are; to define the Self-Efficacy related to Mathematics Literacy and Critical Thinking Dispositions levels, to evaluate them in terms of various socio-demographic varieties, to study the connections between Mathematics Literacy Self-Efficacy and Critical Thinking on Chemistry and Chemistry Engineering students from Engineering Faculty. In this research the sample is constituted by Chemistry and Chemical Engineering Students and the model of the research is relational screening model. As data collecting instruments: The California Critical Thinking Disposition Inventory (CCTDI-R), which is improved by Facione, Facione and Giancarlo (1998) and adapted to Turkish by Kökdemir (2003) is used besides Mathematical Literacy Self efficacy Scale (MLSS) which is developed by Özgen and Bindak (2008) [3-5]. SPSS 16.00 is used to analyze the data. ANOVA, independent T-Test has been conducted to monitor the scores taken from the scales in terms of socio-demographic varieties. PEARSON correlation coefficient analysis technique is applied in order to observe the relations between the scales. As a result of the data analysis, it is found out that the scores taken from MLSS are not statistically meaningful regarding the variables of gender, department and graduated secondary school while the scores taken from some of the CCTDI-R factors are meaningful according to the gender and graduated secondary school variables and again for CCTDI-R factors according to the department group it is visible that all of the factors are not meaningful. It has been defined that statistically among all factor scores of scales have positively meaningful relations.

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SCIENTIFIC LANGUAGE RHETORIC: FROM THE THEORETICAL BASIS TO THE PRODUCTION OF DIDACTIC MATERIAL FOR UNDERGRADUATE CHEMISTRY TEACHING

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The main objectives of this research were to develop and to implement a tool - the Characterization Map of Scientific Text - which could assist students in recognizing the structural and rhetorical aspects of the scientific language and to investigate its functioning as a facilitator in improving scientific writing of undergraduate chemistry students and as a scientific texts analysis tool. We adopted the theoretical studies of Latour[1] on the rhetoric aspects of scientific articles and the studies of Oliveira and Queiroz[2] on the structural aspects of scientific texts in the chemistry field. We analyzed the main characteristics of the scientific language and elaborated the categories of analysis of the scientific text structural and rhetorical elements, as well as the Preliminary Characterization Map of Scientific Text. We also developed didactic materials about the structural and rhetorical aspects of scientific texts, which were applied in higher education chemistry courses. We analyzed the written production of students in activities about rhetorical aspects using peer review. We analyzed the final scientific texts (reports and mini-articles) written by the students and scientific articles written by researchers in the chemistry field. We also investigated the criteria used by professors in the evaluation of scientific texts assigned related to the courses. From these results we developed the Final Characterization Map of Scientific Text. We also developed didactic material about this Final Map, which was applied in a different class. We analyzed the initial and final texts produced by the students of this class, as well as their responses to an evaluation questionnaire about the activities based on the Map under consideration.

In the activities about the rhetorical aspects, the students developed skills to recognize and analyze critically such strategies in the scientific texts. In the peer review activities, although some rhetorical aspects were also mentioned, the students focused on the structural aspects of the scientific texts. Although considering some rhetorical aspects, the professors focused on structural aspects in the evaluation of scientific texts assigned related to the course. From the activities based on the Final Characterization Map of Scientific Text, the students understood how the scientific text is structured and strengthened, and they improved their scientific writing using structural and rhetorical elements adequately in written texts.

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TEACHING AND LEARNING OF SPECTROSCOPY ANALYSIS

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Spectroscopy analysis is an important course for the students of chemistry, chemical engineering, medical, biology etc.. The main content of this course is principles,feature, rules, technique of UV, IR, NMR, MS and how to determine the structure of organic compounds. Spectroscopy Analysis course has strong features of a great deal of knowledge, difficulty and abstract to understanding, unsystematism, developing rapidly and practical versatility etc.. So there is a general problem in the teaching and studying: students can understand each spectroscopy but have not cognizance of the spectrum and cannot say much things about comprehensive analysis of spectra. In respond to these problems, we explored some teaching reforms and good results were achieved.

1. Emphasizing the effects on molecular energy level

The principle of producing spectra (except MS) is the interaction between electromagnetic wave with molecule. The molecule absorb special frequency light, bring the transition of molecular energy level, and the absorption spectrum is producing. So the factors which can affect the molecular energy level will bring changes on the spectra.

2. The course must advance with the times

According to the fast developing of computer and spectroscopy technology, the newest research achievement should appear in the class.

3. Adding the preparation of spectral experimental sample

Students will benefit from the teaching of appropriate experiment because all the spectra are got from experiment. Preparation of spectral experimental sample affect the result of the test and analysis.

4. Finding the known spectra and grasping spectroscopy analysis English

Comparing the spectra with reference is a good habit, and improving English on spectroscopy analysis is helpful for student to know the developing of the outside world.

What we do fosters the enthusiasm of students to study the course of spectra analysis, and improves their ability for analyzing and solving practical problems.

We acknowledge the support of Shaanxi province quality courses program "spectrum principles and applications".

THE EVALUATION OF ANXIETY LEVELS OF CHEMISTRY, PHYSICS, BIOLOGY AND PRE-SERVICE SCIENCE TEACHERS STUDENTS TO CHEMISTRY LABORATORY

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Laboratory activities can be effective in helping students construct their knowledge, develop logical, inquiry-type skills, as well as problem-solving abilities. In addition, the laboratory in enhancing social interactions that can contribute positively to developing attitudes and cognitive growth. But students' anxiety in laboratory negatively affects learning and performance in laboratory situations, problem-solving skill. [1,2].

The aims of this research are; to define chemistry laboratory anxiety levels, to evaluate them in terms of various demographic varieties on Science, Engineering and Education Faculty students at General Chemistry Laboratory. The population of this study is formed by first class students from Science Faculty, Physics and Biology departments, Engineering Faculty, Chemistry department, and Education Faculty, Science Teacher department taking "General Chemistry" course. For research a two fold form has been created. In the first, demographic information has been collected. Second part includes Chemistry Laboratory Anxiety (CLA) scale, which is improved by Bowen (1999) and translated into Turkish by Azizoğlu and Uzuntiryaki (2006). CLA scale a total is composed of 4 factors [3,4]. These factors are defined as: "Using laboratory equipment and chemicals (ULEC)", "Working with other students (WOS)", "Collecting data (CD)", "Have adequate time (HAT)". SPSS 16.00 is used to analyze the data. ANOVA, independent T-Test has been conducted to monitor the scores taken from the scale in terms of demographic varieties. As the result of data analysis, for all the groups the highest anxiety level is seen on the first factor of the scale, which is "Using laboratory equipments and chemicals". According to the variables of gender and department for the factor score of "working with other students", the difference between the arithmetic averages of the groups are found statistically meaningful. According to the gender variable in the departments of Biology, Physics and Chemistry, for all the factors of CLA the difference is statistically meaningless, while in Pre-Service Science Teacher Department for all the factors of the scale, the difference is meaningful.

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ENHANCING THE PERFORMANCE AND ATTITUDE TOWARDS PRACTICAL CHEMISTRY SESSIONS BY MEANS OF ICT

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Various programs for 1st bachelor students in sciences, bio-engineering, pharmacy, medicine, etc contain chemistry as one of the fundamental courses of the study program. Usually this chemistry course is a combination of lectures, seminars and practical sessions. The practical sessions are meant as independent learning situations in which students acquire and/or practice specific manual techniques, skills or work methods by performing experiments that support the theoretical concepts. In the past it was observed that a large part of our first bachelor students at Ghent University considered these practical courses of minor importance and not very stimulating, and that a lot of them came to these sessions unprepared, hardly realizing what was expected.

A possible explanation for this rather negative attitude was that the main part of the course evaluation was based on knowledge and application of the theoretical concepts during an end-of semester-examination and that the students had the impression that their performance during the practical sessions was therefore less important. To deal with this attitude, we introduced the electronic online- examination environment “Curios” of Ghent University as a tool for (self-) evaluation. Before coming to the lab, students have to use this electronic platform to solve 10 multiple-choice questions regarding the experiment and the underlying concepts. The evaluation is included in the final marks for the course. The result was a noticeable increase in the involvement of the students towards the experiments and –as a consequence- a better performance in the lab.

To deal with the prevailing view that the practical sessions were not motivating, the offered experiments were critically evaluated. A major part of them was replaced by new experiments in which ICT was implemented and parameters such as temperature, pH, absorbance, etc.. are measured in real time by means of sensors and a Coach® interface. With this type of experiments, the data can immediately imported into a spreadsheet program and analyzed. Preliminary results show that with the introduction of the new experiments, the perception of students towards the practical sessions has evolved towards a more positive attitude.

The foregoing results clearly show that the introduction of ICT in practical sessions may have a substantial effect on both the performance of students during practical chemistry sessions as on their attitude.

ICT AND MODELLING IN CHEMISTRY TEACHER EDUCATION

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While information and communication technologies (ICT) have become widely used in modern society, they are still awaiting for a breakthrough in wide spread educational use. While many technological solutions, platforms, softwares and solutions have been developed, their use in context-base chemistry education seems rather limited especially in secondary and high schools. In chemistry, simulations, modelling, computer-assisted inquiries and learning environment could create and support inquiry-based research approaches which could forma multifaceted learning environment to be tailored for different learning outcomes and learning aids. Here, especially the teachers play a key role when the use of ICT in schools and in education is considered. Moreover, a generalised approach for teacher training is needed to answer these challenges and meet the opportunities.

A recently adopted approach at the Universities of Jyväskylä and Helsinki in Finland has been to use ICT in a versatile teacher training program at the chemistry department usually directed to educate chemistry researchers.[1] A blended learning environment with introduction to pedagogical use of ICT in teaching and learning chemistry has been the starting point for master level chemistry teacher training. Additionally, a special course Models and Visualisation has been introduced and the modern approaches of using and employing computational chemistry and molecular modelling, visualisation of chemical entities and simulations of chemical processes have been introduced – all biased for chemistry education and training future teachers to use and apply ICT in their teaching. Especially, the Models and Visualisation course have been accompanied throughout the years by educational research to understand the impact and impressiveness of the training during and after the studies.[2]

In this presentation, the adopted Finnish model for training future chemistry – and science - teachers into skilful ICT users in educational context is reviewed and illustrated.

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MY CHEMISTRY CLASSES: EVOLUTION FROM THE BOARD AND CHALK TO THE MULTIMEDIA TECHNOLOGY

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As a chemistry student all my professors used the traditional board and chalk to give their lectures. When I begin teaching I also used the same methods, but always trying to create new ways to help my students to overcome the difficulties that I had experienced as a student. This is still today the driving force that leads me to apply the ICT (Information and Communication Technologies) to the teaching process. Quickly I realise the powerful tool that I have at my disposal to improve the processes of teaching and learning [1-4].

The multimedia chemistry lessons are a serious advantage for the students, in a area such as chemistry, where the visualization of the processes is essential for a correct understanding of content[5]. However, as time passes by, the teacher will increase his Multimedia resources rising a serious issue. ***What contents to use in class****?* This reflective work is based on the author's experience on this issue. Noting that the type and amount of content to be used per class depends on the nature of students, school hours, objectives and competencies to be achieved. Therefore, it is necessary to make a constant assessment of academic nature of the multimedia content in order to use them in the most rational and profitable way.

We will present a particular case of application of multimedia content for teaching and learning of biochemistry with their statistical treatment of data and key findings.

Keywords: Multimedia contents; Blended Learning

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REAL TIME EXPERIMENTS IN CHEMISTRY AS A WAY TO IMPROVE SCIENCE COMPETENCIES IN SECONDARY EDUCATION: THE SPANISH SITUATION

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International assessment of students' competencies reveals that the performance of Spanish students in science is statistically significantly below the OECD average[1]. This situation is a challenge to be faced in several ways. Our work has two aims; on one side we explore the potential of real time experiments in helping the acquisition of Chemistry competencies in secondary school students taking into account the current situation of this technology in Spanish schools, and on the other hand our objective is to give tools to teachers to use effectively real time experiments to practice competencies with their students.
Real time experiments can be obtained using Microcomputer based laboratories (MBL) in which one or more sensors are connected to an interface and the results of the measures are obtained in real time. This technology allows students to see in real time the graph of the variables measured by sensors during the experiment. If the design of the activity is accurate, and the management of the classroom is adequate, Science and Chemistry competencies can be practiced.

The situation of the use of real time experiments in secondary Spanish Schools is not homogeneous, as it depends on the availability that teachers have of the equipment, on the teacher training and on the views that educators have of competencies. In most of the Spanish Autonomous Communities, teachers can obtain the equipment as a loan from Public Teachers Resource Centres. In Catalonia the situation is much different, as its regional government provided all public Secondary School with Multicomputer Based Laboratories equipment since the year 2000, and promoted the design of teaching materials and a teacher training programme.

In order to make our students more competent, it is desirable to give tools to teachers to promote science competencies in their students when using this technology. We examine Catalan teachers' opinions on competencies[2] based on previous researches, the analysis of MBL activities in the design and implementation of an ICT teacher training course[3], and we present the objectives of a recently started European Project in which synergies with other countries are searched, to deal with this situation.

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TEACHING SILICON ETCH PROCESS USING ANIMATIONS AND MEMS SIMULATION TOOLS

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One of the main challenges faced by the teacher and the beginner in MEMS is; teaching and learning the orientation dependent etch properties of silicon. KOH is one of the popular etchant used in bulk silicon etching, however, its etch properties are orientation dependent. This makes it essential for a MEMS designer to understand these properties clearly to know the final shape of the structure. During the etch process, the structure undergoes many 3-Dimnesional changes in shape. One should be good at drawing and visualising these 3-D changes. It becomes a Herculean task for the teacher to teach this etch process. Through this paper an attempt is made to explain how effectively ICT can be used in teaching the etch process.

Thus a conventional teacher who is poor in drawing, may fail to convey the etch process. Instead if he uses a simulation tools and grabs frames at various time intervals and presents it as a video or in a PPT he can effectively explain the etch process. Tilt and rotate options in these tools enables the teacher to explain the changes that are taking place on all sides and corners.

INTEGRATION OF VIRTUAL ENVIRONMENT FOR CHEMISTRY STUDENTS AND EDUCATORS IN LATVIA

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Modern chemistry teaching and learning process is characterised by life long continuity and content integration in all stages where it is carried out. It also demands very close interaction of all its participants [1]. The communicative aspect of training process depends not only from presence of necessary competence, but also from availability of information. Nevertheless, research which was carried out in Latvia in 2009 had shown that separate participants of educational process (students, teachers, chemistry teaching methodologists) had difficulties in finding necessary information in the area of chemistry education. Especially, it concerned data about history of chemistry and chemical industry (difficulties had 78,7 % of interviewed), a modern condition of science and technology in Latvia (66,4 %) and other aspects of local character.

Teachers and students recognised that there were difficulties in communications - there was no easy access to historical information about seminars, courses, conferences on didactics of chemistry and other related fields (82,2 %). In total 348 respondents participated in survey, of which 82,0 % were secondary school pupils, high school students and teachers from the different regions of Latvia representing various types of educational institutions.

To correct existing situation, a webpage “Kimijas Skolotajs” (“Chemistry Teacher”) was created in 2010 [2]. Its content covers full spectrum of the problems related to education of chemistry at all levels. Here can be found information which of interest for students, their parents, PhD students, teachers and chemistry teaching methodologists. We have also published here instructional materials for basic school pupils and secondary school students as per Latvia’s chemistry curricula.

As of 2012, 48,2 % of webpage registered users were school pupils, 36,3 % - school teachers and university lecturers, 14,8 % - universities students and other users - 0,7 %. By an estimation of respondents, accessibility of the information in those areas which were especially hard to access has increased from 16,6 % to 87,8 % within the last two years.

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CASE STUDY ON THE INTRODUCTION OF ICT INTO A PROBLEM-FINDING AND PROBLEM-SOLVING ORIENTED CHEMISTRY CLASS

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Cultivation of a problem-finding and problem-solving potential of students has been a recent demand in the university class besides learning and understanding basic knowledge about a course. To have a question "why?" in students' mind opens the door to the potential. We have previously adopted "Question & Answer Corner" in our Chemistry classes; students fill their own questions in a formatted sheet at the end of session and teachers then answer to each question at the start of the next session. It should be noted that students can make any kinds of questions, even if they are not related to the class or chemistry. This means simple questions about student's daily life are welcome. Releasing the framework made most of students possible to conceive ideas what they should raise as a question and write down. As a result of the repeated practices throughout the class, 60% of 130 students stated that they have learned the importance of having questions and have been surprised by knowing various interests and queries of their class mates.

This Q&A Corner fully works in a small size class. In a large size class, however, only a limited number of questions can be answered in every class and most of questions have to be omitted. To solve this inconvenience, we have introduced Discussion Corner in Web Course Tool as an alternative to the manual Q&A Corner. The Use of the Discussion Corner makes students to put their questions on the web site and ask the answers from other students. Students also have a chance to browse current concerns or queries of other students. As an incentive to students, 0.5 points were given to each of question and answer submitted to the Discussion Corner (upper limit of the point was set to 15 points). In the case of Chemistry class consisting of 330 students, more than total 5600 queries and answers were uploaded on the site. In addition to that, the teacher became able to save time for answering question. In the above same question, about 80 % of respondents answered that they have learned the importance of thinking. A typical answer was as follows.

"Through the 15 sessions of Chemistry I, I have noticed there are many questions in every place of our daily life. I have solved these questions using Discussion on the Web Course Tool, Communication Paper and Self-disciplined Report. By studying this class, I became to have a custom to note down my questions and strange things in daily life. So, I am always ready to do now. I have learned it is much important for living to find a certain problem, study the subject and find a solution by myself rather than the cramming of knowledge on Chemistry. I have also learned asking helps to someone who has enough knowledge on the matter as another way to solve the question, when I can't find the solution. I think the things I have learned in this class must be very important for me to live on and to drive for engineer. This class has only 15 sessions, but the things I have learned were much worthier than the ordinary 15 sessions. Thank you very much for your excellent instruction."

EDUCACIÓ QUÍMICA EDUQ: A JOURNAL ON THE TEACHING OF CHEMISTRY WITH A EUROPEAN PERSPECTIVE

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In this paper we present the magazine *Educació Química EduQ*[1], published by the Catalan Society of Chemistry with support from the Institut d'Estudis Catalans and we analyze papers published in the first 10 issues from the point of view of the section, the educational level, the language in which they are written, and the geographical origin of the author. We also provide details of the level of diffusion of the magazine (number of subscribers, number of page hits of the electronic version of journal, etc.).

While the magazine is aimed at all education levels (primary, secondary and university), more articles are published about secondary level. It is published three times a year. It is available as both a print edition and electronically. The electronic version is free. Articles are published in Catalan, Spanish, Portuguese, French, Italian and English. We can see that in the first 10 editions the majority of articles were published in Catalan (62.3%), Spanish (19.5%), Portuguese (9,1%) and English (7,8%).

The magazine accepts articles that belong to a set of 15 sections: Chemistry Today, Curriculum based projects, The innovative classroom, Concepts in chemistry, Teaching resources and strategies, Working practices in the lab, New technical innovations, History and the nature of chemistry, Chemistry and society, Chemistry and environmental education, Chemistry teaching research, Teacher development, Students´ research, Chemistry and other sciences, Language and terminology. We can see that more articles have been published in five sections. These sections are: Working practices in the lab, Teaching resources and strategies, Chemistry and society, Concepts in chemistry, and, Chemistry teaching research.

The journal organized, the I Trobada d'Educació Química (First Meeting of Chemistry Education)[2] in 2011. It is expected to convene every two years.

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PROACTIVE TEACHING, THE ŚNIADECKI ACADEMY PROJECT

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Proactive teaching is based on the strategy of introducing students into the cycle of constructivist learning, from the search for references in their own knowledge and the available sources to teacher-assisted systematization and creating the student's own system of evaluation.

A. ACTIVATION

From the list of topics to be taught, students – supervised by their teacher - choose the ones to be prepared at home. The most important at this stage is activating the knowledge that they already have. The teacher is present at this stage only when electronically called by the students.

B. PROCESSING

In order to structure the material collected, students work independently, they can cooperate with each other and the teacher. At this stage, the main aim is to be able to implement such psychological processes as analysis, synthesis, generalization, comparing as well as the processes of reasoning, i.e. proving, explaining and concluding. The instruction given by the teacher constitutes an inspiration, e.g. the students are asked to prepare their individual website or a note on a given subject stored in the portfolio, or they can publish photos or videos of small-scale chemistry experiments on the platform.

C. SYSTEMATIZATION

Students prepare the presentations of their notes in their portfolios. They also work on the conclusions from the experiments they have carried out. The teacher does not present the material but elaborates on it, interprets, systematizes, explains doubts, and answers the questions that the students might have. After the lesson, students make corrections in their notes and on their websites.

D. EVALUATION AND FINAL MARK

In the process of evaluation, students are expected to decide of the quality of their work and achievement. They have to decide what else could have been added, what sources have been forgotten, how they could have improved the structure of their work or what has changed in their knowledge of the subject since they time they started working on it. For instance, "I knew that, now I know this" or "I knew that it was like that, but now I know it is different." The final mark given to them by the teacher includes their participation in the lesson as well as the content and appearance of their websites.

Reference

S.Dylak, Nauczanie wyprzedzające, OFEK **2011**

A WEBSITE WITH MULTIMODAL TEACHING-LEARNING SEQUENCES USING ICT

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In recent years educational research has shown that teaching has not been successful in training students capable of learning by themselves or capable of obtaining useful information necessary for their academic and professional development. Therefore, there is a need to build educational proposals and supporting didactic materials to develop these skills at high school levels[2].

In this sense, one of the most promising proposals is the design of teaching-learning sequences where the important process is to identify the teaching aims and designing instructional activities in order to address them[3,4]. However, this is still a growing research field.

On the other hand, our XXI century culture is expressed, produced and distributed through multiple media types, by means of different technologies and various representational formats and languages. Since two decades ago various groups, associations and educational specialists claim the need to incorporate new literacies into the educational systems. These literacies should be centered on the acquisition of computer resources, and in developing search skills, selection and reconstruction of data information[1].

The aim of this work is to present the results of research currently in progress at the Chemistry School of the National University of Mexico (PE204110). The general project objectives are: designing, implementing and evaluating different teaching-learning multimodal sequences on ICT, as well as to create an interactive website providing a platform for students to develop their activities under the guidance of the professors. The issues that we will present in the congress are: corrosion, hydrocarbons and polymers.

The methodology consists of a set of activities designed to involve different learning strategies: experimental activities, the search of specific information, problem-based learning and, of course the use of ICT.

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MULTIBOOK, AN ELECTRONIC BOOK

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The school year 2012/2013 marks the beginning of a new school reality in Poland. According to the new curricular basis introduced in our country in 2009, teaching must be focused around the media and the experiment. In the same year, a new junior high school leaving examination was introduced. The above decisions have determined further educational improvements which are of great help both for teachers and their students as well. These include electronic books, or the so called multibooks. One of the biggest educational publishers prepared all of the necessary handbooks for junior high school students (aged 13-15) in a form of a multibook available on CDs or flash drives.

Some of the functionalities of the *Exciting Chemistry*[15] multibook

1. Most of illustrated drawings and diagrams may serve as tasks checking the levels of concentration and assisting students in memorizing the content of the lesson.
2. The tasks that are usually available in the regular handbook, in the multibook are presented to the student in a random order. Obviously, the solution is available along with the task. Thus, students immediately receive the answer whether their own solution is correct or incorrect.
3. A lot of information that was not enriched with illustrations in the printed version, in the electronic book has some illustrations added. It is up to the teacher to decide which and how many additional elements should be added in a given class.
4. The animations, videos and interactive tasks presented on most pages encourage even the less interested students to work.
5. While in the traditional handbook, illustrations constituted just interesting elements, in the multibook students point to a given word with the cursor, their finger, or a pen to change the static drawing into a lively image.

Another advantage of the multibook is a set of tools for interactive cooperation between teachers and students. This is a dream come true for both parties to the educational process. You can print the elements of the books, you can write and draw directly on its pages, you can make notes on special flash cards which will never be misplaced. At the end of the day, the handbook still remains untouched and ready to serve another class.

ICT IN CHEMISTRY TEACHING ON VARIOUS LEVELS OF EDUCATION

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The computer and the Internet have become integral elements of the contemporary young people's natural habitat. They communicate with each other by means of social networks; they meet new friends, they learn new things and broaden their interests. Digital Natives is a generation which cannot imagine their life without the Internet (1). Five years ago, Polish parents declared that 72% of children aged over three use the computer (2). Furthermore, the average monthly amount of time students aged 7-14 spend in front of the computer screen amounts to 49.5 hours (3). Research carried out on a group of high school students in their senior year pointed to the fact that 72% of them do not see any point participating in regular in-class lessons, and 79% of these students find their lessons not very interesting (4). The situation is similar in Polish schools. Thus, a question arises how to make the school more interesting for the digital natives. What can we do to motivate them to make more effort to learn? How to bring the school closer to their interests and their life outside the school? One of the answers to the above questions could be platform-assisted learning. It can be used for:

- teaching natural sciences (Biology and Chemistry) by asking questions and carrying out discussions with the teacher concerning the animations prepared and placed on the e-learning platform (5)
- teaching Chemistry by developing key competences; e-learning units have been prepared as situations experienced by the avatars in the real life as well in laboratory situations (6)
- teaching Chemistry is started even before the traditional lesson starts; by means of the Google apps platform, students prepare for classes according to the instructions received from the teacher, which allows them to discuss the topic at school in a problem and multi-contextual manner. The preparatory process is managed and inspected by the teacher via the platform. Students store the materials in their files and then create their individual digital portfolios (7).

The educational platform-based learning may take place at various times and place which makes it possible for the users to continue their development outside the classroom and expand their interests beyond the material normally required at school.

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ODYSSEY AND SPARTAN AS EDUCATIONAL SUPPORT AT HIGH SCHOOL LEVEL

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Nowadays, the world has been overwhelmed by the massive number of issues that can be accessed by the use of Internet web sites. This represents a challenge for educators: to enable the students to select, classify, interpret and evaluate information for the study of a specific topic as well as consult the sites appointed for that purpose by teachers. Particular spaces can be created with the intention of allowing students to display their work and receive feedback from their peers and teachers which will additionally make them feel proud and happy. In this work we present examples of the work made during the past school term using simulators like Odyssey and Spartan.

INTERACTIVE MEDIA, NEW OPTIONS FOR TEACHING CHEMICAL NOMENCLATURE

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The field of educational media every day presents new tools to support teaching and learning methodologies, today we can find in any classroom at any level, whether a computer either desktop or laptop and a projector that would have simplified the teacher teach the way and give feedback to their students.

However, in the most cases, the resources presented in class may be limited and only take programs like Power Point or video sharing on the internet, leaving aside other options for building materials. In this case the proposal that we addressed is by tool and flash action script program to develop an interactive step leading to the student from one level of education such as primary, in his first approach to chemical language, helping you know the table Periodically, your organization and each of the elements that compose it, its history, its origins. On the other hand, is introduced to his first set of training compounds and simple theories such as the Lewis octet, electronegativity, Acid-Base, halogen acids, etc.. All this through simple animations triggered by a click, the student can consult documents included in the dvd in pdf format. The creation of these animations are based on the theory of Richard Meyer on Educational Multimedia [1] where he stresses the need to teach by two media attention (seeing, hearing or touch) thus reinforces knowledge. The interactive material is available on DVD and web site for consultation.

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THEORETICAL STUDY OF ALKALINE HYDROLYSIS OF N,N DIMETHYLACETAMIDE

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Chemistry Organic it is a science that is learned by observation and from same doing, this conception causes that the use of computacionales programs constitutes a fundamental tool for the acquisition by part of the students of capacities of the conceptual and procedural type. The programs of three-dimensional visualization of the organic compounds structure and programs of calculation of different geometric parameters, including the calculation of their minimum energy, they must be always present as much in the education-learning process, like in tasks of investigation in the Organic Chemical area.

A theoretical study of reactivity of N,N dimethylacetamide hydrolysis, aliphatic amide, catalyzed by alkali, from the analysis of intermediate was carried out. Geometries of all species involved in the hydrolysis was made and identified. The software Gaussian 03[1], to determine geometric parameters and calculate the energies of all reagents and products was used. Computational method to study the reaction using alkaline catalysis[2] and an experimental work[3], agreed that this reaction takes place with the formation of a tetrahedral intermediate. The reaction and the compounds studied are shown in Figure 1.

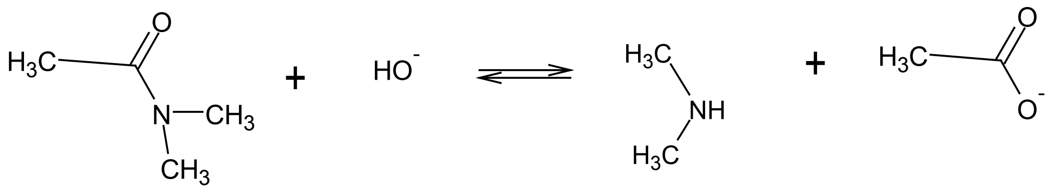

Figure 1. General Scheme of Alkaline Hydrolysis of N,N dimethylacetamide

Energies, lengths and binding angles values obtained were compared with bibliographic and experimental data. Following the same procedure it was identified the geometric parameters and energie of reaction intermediate. The activation energy was 24.95 kcal/mol.

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WEB-BASED LEARNING ENVIRONMENTS IN CHEMISTRY EDUCATION

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International publications (PISA, Eurobarometer)[1] [s]how that, for most young people, the motivation to pursue studies in sciences is rather low. Considering an increasing recognition of the importance and economic utility of scientific knowledge in an industrialized society, the general lack of interest in science and the resulting reduction in the numbers of young people choosing to pursue the study of science has become a matter of considerable social concern and debate[2.] It is therefore crucial to look for alternative teaching methods to motivate pupils to study sciences and to pursue a career in science and technology.

An important reason for the lack of interest in sciences is that this field is very often experienced as dull and difficult. New learning methods, using a contextual and inquiry-based approach to make science fit-in with the pupil's environment, appear to be effective in improving the student's motivation. For chemistry, some countries have already implemented this approach in their curriculum[3-5.] When ICT-technologies are integrated in such an approach, powerful computer-supported learning environments can be created. One of these environments is the Web-based Inquiry Science Environment (WISE) which has already proven to lead to effective learning gain in secondary science education[6,7.] However, the implementation of these innovative learning environments is still lacking in higher education and insights regarding the effects to learn chemistry is limited. In this regard, this study investigated the implementation and impact of WISE[6] as a computer-supported collaborative learning (CSCL) environment in the chemistry curriculum of first-year bachelor students. Two different subjects were taught to two groups of students, the experimental group used the WISE environment, the control group dealt with the subject in a traditional classroom setting. Effects were measured based on a pretest-posttest design and the outcomes were analyzed as a function of prior knowledge, motivation and learning style.

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ELECTRONIC WORKBOOK INSTEAD OF A TRADITIONAL WORKBOOK

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In 2012, the knowledge and skills of Polish students will be verified by the new junior high school final exam. To meet the challenge, a Polish publishing house, Wydawnictwa Szkolne i Pedagogiczne prepared a portal WSiPnet.pl. WSiPnet features attractive electronic workbooks which bring numerous additional advantages for students and teachers. WSiPnet makes it possible to save time necessary to correct the tasks and convey the results to the students. Once the students finish the exercise, the correct result appears. It is simultaneously available to students and teachers. Thus, homework checking is not longer so time consuming as it used to be. Within seconds, each student's task is marked and the whole classes' results are available the the teacher's fingertips. The instant feedback motivates students while the report on the class' results makes it easy for the the teacher to monitor the level of implementation of the curricular basis.

For instance, a Chemistry teacher needs less than 20 seconds to send the task concerning particular topic. Students complete the task within the time specified by the teacher, obtain the result and the teacher receives a report pertaining to that task. Each task is accompanied by the correct result but also with the information on the elements of the curricular basis the task involves. The teacher has access to reports of various types which are generated automatically and make it possible to monitor the progress of the whole class and its particular students.

The teacher has direct access to the report charts therefore it is possible to check a given student's solution to the task and the mistakes they have made. WSiPnet ensures that each and every student from a given class is continually monitored. By doing particular tasks, students practice their skills defined in the curricular basis, they can see their own results and based on them, carry out their own self-check. When analyzing their own mistakes, students can see their progress, their shortcomings, and successes. There is a set of tasks for every lesson so students can easily see what needs to be done. From the reports, students can find out what elements still require some attention while planning revisions before the test.

In the WSiP system, the teacher can see who has done their homework and what result they have obtained. This motivates students to do their home assignments more frequently, which is of vital importance in developing the habit of systematic work.

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ELECTROLYSIS: A CHANCE TO TALK ABOUT CHEMISTRY, BUT ALSO HISTORY, ECONOMICS, ENVIRONMENT

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Generally placed at the end of a course of General Chemistry, electrolysis does not always receive the appropriate consideration to teaching. On the contrary we believe that its emphasis in Chemistry lessons for students of high school or university, is an opportunity to reaffirm fundamental issues of discipline and also to give a complete picture of it, in all its complex plots with surrounding reality.

First, the study of electrolysis may provide a further example of the thermodynamic aspects of chemical transformations, because the process can be seen as the realization of a reaction "not spontaneous". Only at the expense of energy supplied from the outside can be realized, for example, the decomposition of sodium chloride in sodium and chlorine, by inverting the direction of the reaction between the two elements, which on the contrary are able, if placed in contact to react in a vigorous manner, with development of large quantities of heat.

As is known, currently the electrolysis of NaCl melt is industrially carried out using the process devised by J. C. Downs . The analysis of the plant allows to emphasize topics of Chemistry, already addressed in the preceding parts of the course, such as the physical characteristics of solids, the concept of liquid miscible or immiscible, the lowering of the melting point of a mixture, etc.. It may also be emphasized how the process Downs for the production of metallic sodium supplanted the one devised by H. Y. Castner, and explain why in the XIXth century this element was so important. As is known, it was the basis for the industrial preparation of aluminum, before it was developed another electrolytic process, thanks to C.M. Hall and P. L. Héroult. This in turn requires, as a raw material, purified alumina, obtainable by processing the bauxite by the method Bayer.

This can be in our view an important opportunity to reflect on the role of chemistry. The production of aluminum appears to us now of inestimable value as the vast number of applications involving this metal, so abundant on our planet. On the other hand, the purification of bauxite inevitably produced in large quantities a solid residue, the so-called "red mud", responsible for much damage and environmental problems in various parts of the world. This can be an example of the continuing challenge, difficult but fascinating, that the chemistry has to constantly deal to be truly sustainable. It 's an opportunity to understand how, even today and tomorrow, the chemistry, the so-called "Green Chemistry" should, among other things, be able to convert or modify old technology, now considering them in light of their environmental impact and eco-compatibility.

VISUALIZATION IN SCIENCE AND EDUCATION: OUTCOMES OF GORDON RESEARCH CONFERENCES FROM 2001 - 2011

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This poster illustrates the people, history, and goals of the biennial Gordon Research Conference on Visualization in Science and Education. This small (~140 attendee) biennial interdisciplinary conference (http://tinyurl.com/grc-viz2011) provides a forum for the critical examination of the uses of visual images and the tools used to create them for learning in all areas of physical, biological and computer science, engineering, and technology. A number of full-scale NSF-funded research projects have emerged from collaborative mini-grant teams formed during the conference. The Conference brings together scientists and educators who use (and create) visualizations for research and classroom use and test their effectiveness along with graphics, video, and design specialists who create visualizations to advance the frontiers of science and mathematics, and cognitive scientists whose understanding of human perception and cognition guide the research and educational application of visualizations. Conference planning is already underway for July 2013 and 2015.

PUBLIC PERCEPTION AND EXCITING YOUNG MINDS WITH CHEMISTRY

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During the last 28 years, we have been active in the design and presentation of chemical demonstration lectures to schools and public audiences. We have further developed and refined these 'shows' to tailor them to suit audiences in different specific age groups. At the year 7/8 level, we focus upon aspects of physical and chemical change and the properties of gases.[1] At the year 12/13 level, we focus upon energy and rate in chemical reactions.[2]

Although firmly imbedded in fundamental chemistry, the shows are designed to be entertaining throughout, the educational aspects follow by enthusing the audience and stimulating further interest and enquiry.

By carefully selecting demonstrations, we can easily 'tune' the demonstration lecture shows to suit any audience, including general non-scientific public audiences through to scientifically aware audiences at any level. For younger (schools) audiences who may not yet have chosen to study chemistry, we focus upon the colour, spectacle and exciting behaviour of chemical systems whilst clearly exemplifying the wider relevance. For students studying chemistry, we develop fundamental themes emphasising the importance of chemistry and showing how underlying principles can be illustrated and made easily understandable with colourful demonstrations.

Demonstration lectures require significant preparation by trained staff and careful attention to health and safety issues and are thus commonly most readily delivered at the location where the preparation is done (and there are facilities for handling chemicals). A key aspect though of entertaining wider audiences with well resourced and comprehensive chemistry demonstration shows is overcome the requirement of large audiences to travel (often considerable distances) to such a central location. Correspondingly, we have also developed methods for the safe transportation and delivery of chemical demonstrations for these shows and we can now safely include spectacular chemical events that are otherwise violent or dangerous if handled in the wrong way.

Using these methods we can now reliably travel to remote locations (in a standard rental van) at will and we have delivered performances across the UK. We have also delivered shows where the chemical preparation has been done in remote locations where there are basic laboratory facilities and we have also successfully delivered these shows to venues in Ireland and elsewhere in Europe.

We will present these methods and how we collect appropriate demonstrations that primarily entertain the audience whilst allowing fundamental principles underpinning chemistry to be introduced and explored in as much detail as is appropriate for the particular audience.

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IMPROVING TEACHING AND LEARNING USING ICT – A 'DIY' APPROACH

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Chemistry teaching in secondary schools has been revitalised in recent years due to the ready availability of computers, data projectors, interactive whiteboards and the Internet.
Topics strengthened by 'visualisation' and 'animation' have brought greater understanding to the classroom and have raised motivation in students studying the subject from the early years to 'A level'. A plethora of software is now available; some of it is good and some less so. Now, some hard pressed school teachers find it difficult to assimilate all the available support material. In fact so much e-learning information can be counterproductive with some teachers resorting to "chalk and talk" rather than searching through an e-learning resources. In addition, a significant amount of software drives the pedagogy and inhibits teachers from taking full control over their lessons. These impositions together with teachers' sometimes poor ICT skills contribute to a "lack of progress" in the development of good lessons supported by the medium.
Teachers need,

- **ICT training**, *developing basic skills and enabling teachers to create their own high quality teaching resources which they can make available to their pupils on their school intranet or website[1], [2].*
- **Chemistry Software**, *distributed nationally by RSC and SEP [3], [4] which can be used as 'stand-alone' resources or 'unpacked' to allow teachers to embed these resources in their own lesson material and make available to pupils outside lessons.*
- **High Quality movies**, *available through the RSC and SEP produced by the School of Chemistry, Cardiff University, which can be embedded in lessons to reinforce topics or show what, cannot be delivered in a school laboratory.[5]*
- **Flash animations**, *produced by the School of Chemistry, Cardiff University to support first year undergraduates and secondary school students.*

This talk highlights some of the simple DIY techniques that teachers in the UK have been encouraged to develop and allows delegates to see examples of some of the very useful e-learning resources targeted at good teaching together with new e-learning materials for 2012/13 available from the RSC and Cardiff University.

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HAPTICHEM - A MULTIDISCIPLINARY PROJECT TO IMPROVE CHEMISTRY TEACHING WITH HAPTIC DEVICES

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Haptic technologies, enabling users to interact with a system through the sense of touch, can provide a useful help in training or education [1]. At this aim, this work describes Haptichem, an interdisciplinary project carried out within the Alta Scuola Politecnica [2], an international school for young talents to promote innovation in the fields of engineering and science, with the collaboration of external institutions. The project focuses on the design and development of a framework equipped with a haptic device for the tactile exploration of molecules and the simulation of the docking and folding phenomena between pairs of molecules. This poster will present the possible scenarios for the introduction of the framework into didactic and research activities. Steps of the research will include: a) the definition of the theoretical and computational models behind the simulation of a molecule-ligand interaction; b) extension of the tool from an initial base of molecules to be considered, to the interaction of complex chemical compounds and proteins; c) design and specification of possible marketing strategies that could make it a commercial product for the didactic and scientific market; d) highlight the drawbacks of currently available haptic technologies, that could stop their spreading in the current consumer market, and possibly propose the specification of an innovative haptic device to "fill the gap".

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USING A WORD ASSOCIATION METHOD TO STUDY STUDENTS' KNOWLEDGE STRUCTURE RELATED TO ENERGY SOURCES

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A word association test was used to study students' knowledge structure related to energy sources. This method clearly distinguishes between students of different grades and different types of schools. It was found that the complexity of both interconnection networks of stimulus words (energy source, renewable energy sources, non-renewable energy sources, coal, oil, nuclear energy) and of association maps was increased by the grade from 7 to 12, and by the type of school in the following order: trade school < vocational school < secondary grammar school. Based on the constructivist learning approach we can interpret the very strong connection between 'oil' and 'non-renewable energy sources', the isolation of 'nuclear energy' and its negative associations, furthermore the wrong connection between 'nuclear energy' and 'renewable energy sources'. Our results support that the word association test is a simple, quick and effective method for exploring and studying students' knowledge structure.

HOW GREEK PUPILS AND STUDENTS CONCEPTUALISE BURNING

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In September 2009 a quantitative research was conducted using a close-ended questionnaire [(1)]. Given the fact, that the use of mixed methods research in educational research increases the validity of the results, [(2), (3)] in November and December 2010 clinical interviews in 10 interviewees aged from 8 to 19 years were also conducted. A proper way to depict interviewees' naturalistic forms of thinking is the clinical interview [(2), (4)]. In this study the main goal was to investigate how interviewees conceptualise burning –therefore two phenomena were "discussed": burning of carbon and burning of wax. Brown's (1995) theoretical background was used for the analysis of the clinical interviews, [(5), (6)]. The related results of the burning and particularly what is happening in a lit piece of carbon or in a lit wax are given below:
(a) Most interviewees' reasoning was driven of an implicit model, which is named loop model, (fig. 1). The characteristic of the loop model is that the fire or the flame is the precursor and simultaneously the result of the burning. (b) The conceptual recourses as well as the instability of reasoning are increasing as a consequence of interviewees' age. (c) Interviewees' descriptions regarding burning of wax differ from those which explain the burning of carbon, although the conceptual recourses are similar.

Based on the above observations we come to the conclusion that the understanding of both gas state and chemical substance is crucial to obtain a satisfactory understanding of combustion [(7), (8)].

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CROSS-CURRICULAR EDUCATIONAL TOOLS DEDICATED TO WATER RESOURCE POLICY PROBLEMS

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One of the important goals of the Educational Research Institute Science Section is to provide teachers with inspiration, novel solutions and ready-for-use, free of charge educational tools. The main role of those tools, which are anchored in the new Polish Science Curriculum, introduced in schools in 2008, is to show Polish teachers how to evaluate students' thinking skills. We propose here a cross-curricular set of tools teaching about water resource policy problems with their full characteristics as well as some tips on how to introduce them during classes and what kind of problems may occur during their use. This set was prepared to synthesize and broaden students' knowledge from different sections of Polish Chemistry, Physics and Biology Curriculum for ISCED-2 level and deepen their understanding of water resource problems.

CONCEPT MAPS AS A TOOL IN TEACHING ORGANIC CHEMICAL REACTIONS

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The research results show that concept mapping has a positive impact on understanding science concepts and their interrelations[1.] The research results are presented, in which the impact of the included expert concept map on the understanding of the concept cluster of an organic reaction was examined, involving a sample of 186 students (aged 17.8 on average).

In the first phase of the research the concept map was produced representing the reactions of hydrocarbons, organic halogenated compounds and organic oxygen compounds2, whereas in the second phase the produced concept map was introduced in the lessons. The purpose of the research was to establish the impact of the concept map application at chemistry lessons on effective solving of tasks with the organic reactions contents. Its impact was tested on a sample consisting of 186 students (the average age was 17.8 years), that were divided into the control group (88 students) and the experimental group (98 students). Prior to the beginning of the experiment the groups were equalized in terms of their level of development of formal logical thinking3 and regarding their average grade in chemistry. As a quantitative instrument for measuring the impact of the applied concept map a knowledge test was used, consisting of five problem tasks, each comprising many parts. The contents of the knowledge test were selected on the basis of the chemistry lesson plan for gimnazije (general upper secondary schools). The analysis of the task solving showed statistically significant differences in the responses of the experimental group members and the control group members (experimental group M=15.9; SD=6.33; control group M=13.6; SD=7.93; p=0.03). The produced concept map contributed to more effective interrelation of concepts and, consequently, to more effective problem tasks solving. In the qualitative part of the research the structured questionnaire was answered and the half-structured interview was conducted. The analysis of the response results showed that students are reluctant to solve problem tasks, due to their problems with reading and understanding the text tasks, with interrelating the concepts of various content clusters, and consequently with misunderstanding of the learning content.

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CONCEPT OF MOLE IN CHEMISTRY CURRICULUM IN THE SCHOOL – PROBLEMS AND SOLUTIONS

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Development of conceptual thinking in chemistry teaching/learning is the process where as a result student learns to select and conceive information, to form links among knowledge based on the existing one, to solve problems, to evaluate conditions and to make decisions. To develop conceptual thinking there is need to form the comprehension of students about different concepts of chemistry. Evaluation of the student's comprehension of concepts is of interest to scientists as well as to teachers.

Concept of mole is not only one of the chemistry basic concepts necessary in calculations but it is important background to such chemistry concepts as stoichiometry and concentration of solutions. Concept of mole causes problems to the teachers and to the students as well [1, 2]. As one of possible reasons could be that when forming comprehension of chemistry concepts by using three level model elaborated by Johnstone (macrolevel – percepted by senses, submicrolevel – atoms and molecules and representative level – symbols, reactions, molarity) most of chemistry teaching is focused on the submicro – symbolic pair of the triplet [3], what does not facilitate formation of the comprehension of concept.

At first knowledge of students and their skills to use definite concept should be ascertained to form a model of the comprehension of concept successfully. The goal of our research was to compare interpretation of the concept of mole in different teaching/learning materials, as well as to evaluate knowledge and skills of the students to apply this concept.

Research was performed in four levels:

1. Analysis of teaching/learning books (definition of mole, in which topics the definition of mole is used).
2. Testing of students to ascertain their knowledge and skills to use concept of mole.
3. Processing and analysis of acquired data.
4. Elaboration of the recommendations and suggestions.

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INCREASING THE ROLE OF STUDENTS' INDIVIDUAL WORK IN CHEMISTRY EDUCATION

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Homework is an important element of the teaching and learning process. Unfortunately, it is not always used effectively in chemistry education. Previous studies regarding homework showed that it does not fulfill all the pedagogical functions which could make it an attractive, effective and independent form of students' work. Based on the results of these studies it was possible to determine which elements of homework need to be stressed and improved. [1]

The aim of the current study was to see to what extent modify the way students' chemistry homework is planned, implemented, checked and assessed would have an impact on their school results, interest in chemistry, engagement in learning and student' autonomy. We used selected assumptions of constructivism as a basis for improving the effectiveness of homework in chemistry education. These assumptions mostly concern the role of the teacher, who is responsible for motivating the students to discover new knowledge and for assisting them in the learning process. By setting cognitive tasks and guiding students in their activities the teacher helps them to discover and acquire knowledge in an autonomous, active way, based on various sources of information. It is also important for the students to control the process of learning and knowledge building; they should be able to evaluate their progress and feel they too are responsible for it. [2] Based on these assumptions the following teaching materials were developed for the teachers participating in the studies: the procedure, tips concerning the types and forms of independent work, as well as the ways of implementing and documenting it. We also developed sheets for assessing independent work, both for the teachers and the students.

The study was carried out in the school year 2009/2010. It involved 110 students of the third grade of junior high school and their teachers. The students were divided into parallel groups. The control group was made up of classes in which students had a higher level of chemical education at the end of the second grade. The teacher in the experimental group organized the lessons so as to allow the students to work independently both during the lessons and at home, according to the tips received earlier. The following instruments were used in the study: a questionnaire for the teachers and students, sheets for assessing independent work and tests. The study found that introduction of modified version of students' individual work help them to achieve better results in the test and made them engaged more actively in classroom activities and in learning chemistry in general. It also increased their autonomy, motivation to work independently and interest in chemistry.

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EXPLORING THE USE OF LOCALLY AVAILABLE MATERIALS TO ENHANCE THE TEACHING OF CHEMISTRY AT SECONDARY SCHOOLS

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Teaching science in poorly resourced schools represents a major challenge not only for students but also for teachers. This paper reports the results of a study done in a State Secondary School in Maputo, Mozambique and was motivated by observation made during school visits on teaching practice. Lack of laboratory equipment and chemicals, overcrowded classrooms are regarded by teachers as the main reasons for pupils' poor performance and failures in exams. The dynamics of teaching and learning chemistry in the large majority of Mozambican schools is similar, pupils take notes of what the teacher writes on the blackboard or dictates [1-3].

The purpose of the present study was to explore the use of diagrams and locally available materials during the teaching of the topic chemical reactions as to investigate their effectiveness on students' motivation, interest and conceptual understanding. Lessons observations, interviews and exams analyses pointed out that many students encounter difficulties in this particular topic.

The instruction was with two grade 9 classes, with quite similar performance in the pre-test. The sample consisted of 117 pupils and 6 teachers. During the instruction, pupils of the experimental group were taught using diagrams and exposed to some laboratory work using locally available materials. In the control group lessons were designed in such a way that information was presented through the traditional expository approach.

Our findings have revealed that the new teaching and learning strategy used led to better conceptual understanding as evidenced by improvements in students' performance in post-tests. The results have also indicated a high level of motivation and interest among students during the lessons and promoted more interactions between teachers and students.

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DENSITY: A PROPOSAL FOR INVESTIGATIVE CLASSROOM

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This paper arises as a class with investigative character and has the intention to provide conditions for elementary school students to understand everyday phenomena and sporadic involving the applications of the concept of density. The proposal came from a problem, which caused a clash of ideas, text production, verbalization and involvement of students, aimed at teaching and learning process[1]. To do so, in the first part, students of the ninth year of primary education were divided into three groups of four students occupying each group, a bench in the laboratory, which had been prepared previously with a 500 mL beaker, an object unknown density and water. We then present a text relating to one hypothetical case of succession of property (problem situation)[2], where the need arises to do a procedure in legal medicine, known as Docimásia Hydro, to determine the fate of a supposed inheritance. Because it is an issue that requires specific knowledge, the script of the lesson was presented to the students the Brazilian Civil Code. At the end of class, have been prepared questions that invited students to think about the concepts of the theme worked and relate them to the Civil Code as well as some information about human physiology. According to the structure of the class and the simple procedures that was presented, the work can be applied to educational institutions that either have or not a chemistry lab, because the materials used in this practice are both accessible and harmless to students.

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THE EFFECT OF COOPERATIVE LEARNING METHODS IN TEACHING CHEMISTRY TOPICS AT SECONDARY SCHOOL LEVEL

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In the traditional approach to secondary school teaching, most class time is spent with the teacher lecturing and the students watching and listening. The students work individually on assignments, and cooperation is discouraged. Student-centered teaching methods shift the focus of activity from the teacher to the learners. These methods include active learning, in which students solve problems, answer questions, formulate questions of their own, discuss, explain, debate, or brainstorm during class; cooperative learning, in which students work in teams on problems and projects under conditions that assure both positive interdependence and individual accountability; and inductive teaching and learning, in which students are first presented with challenges (questions or problems) and learn the course material in the context of addressing the challenges. This study investigated the effect of reading-writing-present and group investigation cooperative learning strategies versus traditional teaching methods on students' understanding of particle structure of matter in a secondary school chemistry course. This study was carried out in three different classes at the secondary school chemistry course during the fall semester of 2011-12 academic year. The first class was randomly assigned as the Reading-Writing-Present Group (RWPG) (n=32), in which the reading-writing-present cooperative learning method was applied the second as the Group Investigation Group (GIG) (n=32), in which the group investigation cooperative learning method and the third as the Non-Cooperative Group (NCG) (n=31) in which the teacher-centered teaching method. Students participating in the RWPG were divided into seven sub-groups. Each of these sub-groups contained five students. The GIG students were randomly divided into two parts (Part I= 16 students + Part II=16 students). The students in these parts were divided into five sub-groups. Each of these groups contained three or four students. The main data collection tools were Background Information Test (BIT), Academic Achievement Test (AAT) and Module Test (MT). MT consists of five modules (MA, MB, MC, MD and ME). The data obtained in this study indicate that there were significant differences at among treatment groups in AAT, MT in favor of the RWPG and GIG.

DEVELOPING GUIDED ACTIVE LEARNING IN CHEMISTRY TEACHING MATERIALS TO TEACH HYDROCARBONS

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This contribution will present one of the ways in which the ideas of active learning, problem solving, and probing students' ideas can be implemented to facilitate meaningful learning. Innovative teaching and learning strategies could be used by teachers at all levels of chemistry education to enhance the students' motivation to learn chemistry (Hanson & Wolfskin, 2000; Eybe & Schmidt, 2004). One of such innovations is the GALC (Guided Active Learning in Chemistry) approach (Devetak & Glažar, 2010). This approach can be used by teachers in order to facilitate learning to learn strategies in students, who can apply them in the future when learning about new chemical phenomena described by more abstract concepts. The GALC is an educational approach that takes place in an environment where students are actively involved in the process of learning chemistry. When students use the GALC approach, they learn new concepts and connections from one another in groups within a social context. Their knowledge is developed by the data analysis and discussion of ideas regarding the learning content. By studying questions at different levels of cognitive demand and by formulating specific conclusions in problem solving, the students are required to meet the demands of the individual GALC learning modules. In this contribution we wanted to show how, from a seemingly simple question 'What compounds form essential oils', one can develop a complex teaching situation that leads to the realization of teaching goals in a unique way. Some results of GALC material for learning about hydrocarbons evaluation in the classroom learning environment will be presented.

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THURSDAY 19 TH
POSTER SESSION 2

UPPER SECONDARY SCHOOL STUDENTS OPINIONS ON HOW TO IMPROVE THEIR CHEMISTRY EDUCATION

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Affective difficulties have been studied within science education since many years. The affective domain includes different parts, e.g. attitudes, opinions, values, beliefs, interests and motivation. To inquire Swedish upper secondary school students' opinions about their chemistry education and to find out what ideas they have to improve chemistry education, two paper-and-pen questionnaires were used. The first was completed by n=372 students in 2007 and the second by n=495 students in 2010. It was not the same students answering the both questionnaires. Results from the first questionnaire have been published elsewhere[1,] and in this presentation, one question from the first questionnaire will be put in relation to results from the second. The question in the first questionnaire was open and students were given the opportunity to express freely how chemistry education could improve to make school chemistry more meaningful and interesting. The different responses given by the students were thereafter used to develop response options for the second questionnaire where the same question was given, but in a more closed way where students were asked to rank the three most important things to improve their chemistry education. The response options were mainly put in opposite pairs, e.g. if the response from the first questionnaire was 'More laboratory work', this gave two response options in the second questionnaire, i.e. 'More laboratory work' and 'Less laboratory work'. In questionnaire 1, approximately 65% (n=243 out of 372) responded to this question. In questionnaire 2, where the question was closed and students were asked to rank, all students answered the question with at least one option. Since they could rank three options, there were in total 1485 (3·495) responses, and only 15 responses were blank in total, i.e. a drop-out rate of 1%.

In general, students want to improve their chemistry education by connecting it to everyday-life contexts, and by having more practical and laboratory work. The open and closed way to pose questions gave somewhat different results which will be elaborated from an accuracy perspective (i.e. validity and reliability)2. Depending on how questions are posed, varying results can be obtained, a result in itself important to discuss and consider.

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THE STUDY ON THE BUILDING AND PRACTICE OF TEACHING CHEMISTRY MODE
IN HIGH SCHOOL BASED ON PROBLEM-SOLVING

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To solve problems in teaching high school chemistry has been regarded as the core process of instruction. In this paper, we try to build a mode of teaching chemistry in high school based on problem-solving and practice it in ordinary instruction. The mode include four processes, they are making problems, deciding the methods of solving problems, practicing the process of solving problems, and assessing the results.

In daily teaching, a lot of problems can be transferred from the core knowledge of textbook. We study the mode based on practicing in schools. While, during the practicing, we focus on the ideas building, the instructional design, the learning plan design and the assessment. Currently, the study is being implemented, and has made some achievements.

Key words: chemistry teaching; problem-solving; teaching mode

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TALKING ABOUT MISCONCEPTIONS IN CHEMICAL EDUCATION: THE CITRIC BATTERY

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The citric battery is an example for a source of energy made from everyday materials which is often referred to in class when dealing with the workings of electrochemical batteries and corrosion. This type of battery works by inserting two electrically connected electrodes into a lemon fruit, one made of zinc, the other of copper. An electrical load between the electrodes can be used to confirm that an electrochemical cell has been formed.

Contrary to what one might believe, it is not trivial to find the correct approach to explaining what is going on in this easily set up experiment. In fact, there are numerous explanations that present a multitude of misconceptions. One explanation, for example, proceeds to say that copper ions from the solution accumulate on the copper electrode, similar to the what happens in a Daniell cell (cf. Formula (a), [1]).

$Cu2+(aq) + 2\ e- \rightarrow Cu(s)$ (a)

Focussing beyond what happens at the electrodes, several other false explanations can be found, such as the notion that electrons migrate from the copper electrode through the lemon solution to the zinc electrode [2] or that the electrons originate from the acid of the solution, being unequally attracted to both metals [3].

This research has cued an examination with the purpose of assessing how high-school students who had already covered electrochemistry and corrosion and students of chemistry in higher education would explain the workings of a citric battery. The examination also presented some of the misconceptions we found earlier.

To address these misconceptions, a teaching unit for high-school students was developed to enable students to closer research the electrochemical processes within citric batteries in the course of scientific experiments related to hydrogen and oxygen corrosion. The teaching unit includes discussion of problematic explanations from internet sources and of common misconceptions students have about the subject.

The resulting poster then documents the explanations derived during the teaching unit and also the empirically found misconceptions.

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OBJECTIVE DESIGN AND STRATEGY IMPLEMENTATION OF INQUIRY LEARNING ON ENVIRONMENT IN JUNIOR HIGH SCHOOL CHEMISTRY

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This study analyzes the relationships among “chemical teaching”, “inquiry learning” and “environmental education” in the period of compulsory education, and designs the three-dimensional objectives of inquiry learning for junior high school chemistry on the basis of the comparison among the objectives of environmental education in junior high schools, the course objectives of chemistry in the period of compulsory education and the objectives of inquiry learning. The four strategies that we employed in real teaching to guide students to conduct inquiry learning on environment in the course of chemistry by combining columns like “Exercises”, “Activities and exploration”, “Survey and research” and “Discussion” in the chemistry textbooks of junior high schools are introduced by using case study. They are: 1) practicing “Exercises”, which means to do field survey based on the exercises; 2) deepening “Survey and research”, and starting from “solvable problems”; 3) extending “Activities and exploration”, leading the students to experience scientific research; and 4) organizing effective “Discussion”, which is to transform thoughts into actions.

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CONTEXTUALIZATION AS A LEARNING FACILITATOR: A CTS APPROACH FOR TEACHING THE "SUBSTANCES AND MIXTURES" THEME

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Chemistry Teaching focus on the formation of wise citizens by seeking after the development of arguing abilities and decision making. In this sense, the Chemistry classes should be planned around real and current world issues so that students can develop those skills. Thus, the teacher should unroll the theme in a perspective that considers technological and social aspects.1 Due to the existence of a water fountain near the school in which this research was performed, a teaching sequence named "Water Quality" was developed to teach the concept of a substance. The sample comprised ninety 1st year high school students and a questionnaire was applied initially to ascertain theirs conceptions about water quality. The data from the questionnaires were analyzed considering the analysis reference that sought to identify, enumerate and categorize the key elements present in answers2. The results showed that 58% students considered that the water, for being visually clean, was proper for drinking. Moreover, 80% could not differentiate conceptually clean water and pure water. Instead, they classified polluted and potable water considering only the visual aspects. From this analysis, a teaching sequence was built aiming at the scientific literacy of the students, helping theirs decision-making about the quality of the water for consumption on the basis of chemical knowledge. The proposed material, whose activities are shown in Table 1, is being implemented. The authors thank CNPq, CAPES, FAPEMIG, MEC and UNIFAL-MG for their financial support.

Content	*Purpose*	*Teaching tools used*
Surface water and groundwater	*Differentiate drinking water from polluted water;* *Assess the quality of water intended for consumption;* *Recognize the importance of reducing the wastefulness of drinking water.*	*Experimental activities "Analysis of different water samples."*
Water Treatment	*Understand the process steps of water treatment;* *Recognize the role of the citizens in the maintenance of drinking water distributed by water treatment plants.*	*Model, theater, and parody posters produced by students.*
Composition of water used for human consumption	*Distinguish between pure and drinking water;* *Recognize the substances present in water used for human consumption;* *Understand the importance of salts present in the water to the human body.*	*Experimental activities "Measuring the pH of different water samples."*
Element chemical substance and mixture	*Understand the concept of chemical and substance;* *Differentiate substance water of their representation;* *Rate water used for drinking as a mixture.*	*Activities: Molecular models using Clip.*

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THE EFFECT OF CONTEXT BASED APPROACH ON THE LEARNING OF CHEMICAL EQUILIBRIUM

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"Context-based approaches are adopted in science teaching in which contexts and applications of science are used as the starting point for the development of scientific ideas." By presenting scientific concepts in contexts and applications of science is aimed to promote students' interest, attitude and motivation for science. In several countries, context based chemistry curriculums have been designed and introduced. The purpose of this study was to investigate the effect of context-based approach on the learning of "chemical equilibrium" covered in the 11th grade chemistry curriculum. This study was carried out according to quasi-experimental research design of the quantitative research design. Nonequivalent groups pretest-posttest control group design was used. In the experimental group classes, courses were performed by applying context based approach. During courses contexts, activities related to daily life and homeworks related to daily life were used. While, in the control group classes, courses were performed as usual. The sample of the study was consisted of 104 11th grade students from four different classes in "High School" in Erzurum city, Turkey. Data were obtained by "Chemical Equilibrium Achievement Test", "Chemistry Motivation Questionnaire" and "Constructivist Learning Environment Survey". In the analysis of data, descriptive statistics and inferential statistics methods were used. The results of the research show that context based learning is more effective than traditional instruction to improve student achievement and motivation. It was also determined that context based learning contribute more to the constructivist learning environment.

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THE EFFECT OF DISCOVERY LEARNING METHOD ON HIGH SCHOOL STUDENTS' UNDERSTANDING OF DAILY LIFE CHEMISTRY CONCEPTS

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Educational reform launched in Turkey in 2004 has emphasized constructivist instructional approaches. Since 2008, science curriculum in high schools has been implemented according to the constructivist philosophy and transmission of knowledge has been left behind. The receptive learning model suggests the transmission of knowledge from teacher to learner whereas constructivist model give value to learners' own construction of meaning from their experiences; creating knowledge from the interaction between their existing knowledge/beliefs and new ideas (Walsh & Airasian, 1997).

Even though the constructivist paradigm has been adopted in educational arena, Turkish teachers have a tendency to transmit knowledge to their students in "Daily Life Chemistry" Unit. This unit involves the concepts of organic and inorganic compounds, soaps, detergents and other cleaning agents. The reasoning behind this tendency might be the appereance of these concepts in chemistry textbooks. They are presented in the form of knowledge transfer. However, the concepts aformenetioned can be thought via instruction based on discovery learning where problems are posed to encourange investigations (Joolingen, 1999) and examples are presented for promoting inductive reasoning (Hammer, 1997). Thus, the purpose of the study is to investigate the effectiveness of discovery learning model on high school students' understanding of these concepts. A quasi experimental design was benefited in order to examine the effectiveness of the intervention designed and the results were compared with the conventional teaching method. The teaching intervention was put into practice in a first year upper grade secondary (grade 9) Turkish class. Students in both groups (experimental and control) completed the same open–ended questionnaire after the instruction was carried out. The findings indicated the feasibility of the teaching daily life chemistry concepts based on discovery learning theory. They also revealed that the teaching intervention based on discovery learning was as successful as the conventional teaching in helping students to gain knowledge concerning the daily life chemistry concepts.

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DEVELOPING THE CULTURE AND PRACTICE OF SECONDARY SCHOOL CHEMISTRY IN A RURAL SCHOOL IN THE SOUTH OF MINAS GERAIS STATE IN BRAZIL

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This action research project details a secondary school Introduction to Chemistry course in a rural area of Brazil which took the social and cultural context of young people in the South of Minas Gerais state as it´s starting point to then provide an introduction to both theoretical and practical aspects of Chemistry. The project began as a request from the students themselves as their recently inaugurated school was missing a Chemistry teacher, despite this subject being a legal requirement of the secondary school Brazilian curriculum. The methodology and curriculum were agreed in a participative consultation process involving students, their parents and other school teachers and coordinators prior to the start of the project. With monthly weekend workshops in which a range of inorganic, organic and physical chemistry topics were presented, students gained a broad overview of Chemistry over a six month period. Research tasks were set in which students deepened their understanding of the topics covered by looking into relevant aspects of their local environment and farming practices. Porto encourages "respect for the differences in culture and ideas of rural students as a condition for successful pedagogic practice in a rural community." Thus students were encouraged to develop an understanding of their local environment in which their traditional and a scientific standpoint were of equal value.

Laboratory equipment was lent by the British School of Rio de Janeiro which runs both IB and IGCSE Chemistry courses so that the rural students were able to access a range of both simple and more sophisticated experimental practices. "Understanding science helps us to contribute to controlling and foreseeing the transformations that occur in nature" which are prerequisites to promote the development of politically and socially active citizens in rural areas of Brazil and "preventing the wastage of working class educational potential." The project concluded that the acquisition of the culture and practice of secondary school chemistry in rural areas depends on the interaction and support of all members of the school community and public authorities.

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METHODOLOGY OF TEACHING/LEARNING CHEMISTRY FOR GIFTED STUDENTS IN PETNICA SCIENCE CENTER - SERBIA

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Petnica Science Center (PSC) was founded in Petnica near Valjevo (Serbia, Yugoslavia) in 1982 by a group of young teachers, scientists and university students1,2 . It is a unique non-governmental, non-profit and independent educational institution working with young people who demonstrate an inclination and interest in science beyond regular school curricula. Most of PSC's educational activities are designed for upper secondary school students (age 15-19), but there are various of programs for younger students and college undergraduates as well as for teacher training. PSC is consisted of several departments with equipment suitable for the research and teaching/learning in various sciences including chemistry. Contrary to traditional and rigid system, which was dominating in the schools, new styles and teaching/learning methods were introduced in Petnica Science Center. The emphasis is on experimental work; problem solving and students research projects. The equipment and instruments in laboratories of PSC are considerably better than those in the schools (often similar like in the university laboratories for undergraduate students). Beside permanently employed staff from PSC, many researches and scientists from various institutions (faculties, research institutes, medical institutions, and industrial companies) were also engaged for lectures and courses or as mentors of student projects. Furthermore, many young assistants (former Petnica alumni and usually university students) helps their younger colleagues. In spite of their interest for chemistry, many secondary school students did not have enough knowledge and practical experience to define and perform their projects. Therefore, the annual cycle of seminars was designed in order to provide students with theoretical and practical knowledge necessary for their research projects. Methodology for preparation of students and realisation of projects was continuously improved, from large team projects to individual student projects of high quality. The best projects were also presented at the annual conferences of young researchers. More information on PSC in English or Serbian are available at the web site www.petnica.rs or in the yearbook 3 . Students from Yugoslavia also participated several times at other international events such as International Competition “Young Europeans' Environmental Research”. Some of their papers were published 4 .

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TRAINING FOR HIGH SCHOOL TEACHERS OF NATURAL SCIENCE. AN EXPERIENCE IN MEXICO

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We are presenting our experience as participants in a master's degree program aimed at high school level teachers of science (in service), who have university qualifications related to sciences, but lack pedagogical training. There are two groups of 23 teachers in the State of Oaxaca, Mexico who belong to diverse and distant communities -located on the coast, the mountain or the valley, with different problems to deal with in their daily teaching practice. They meet on weekends in the capital of the State, to take the courses. Due to the characteristics of these groups, the course was designed to be partly set in a classroom and partly online, which makes communication a little difficult because some of the teachers are not be able to access the internet.

The course took place in 8 sessions in a classroom and 7 online session forums of 5 hours each. Its aim is to produce educational change through the design and testing of a didactic sequence of an item of natural science that contributes to improve the learning of science at high school level.

In this course we present some strategies that from our point of view promote in students the development of thinking skills in accordance with the constructivist learning model. We include approaches such as inquiry, argumentation and some strategies for experimental work such as the POE (predict, observe and explain). With our advice, teachers designed a didactic unit using some of these approaches.

Since we believe that the evaluation must be based on the teaching and learning model that teachers use, we selected instruments like mind maps, Gowin's V, and other strategies consistent with the constructivist learning model. Herein we are presenting the design and implementation in the classroom of these didactic units as well as their analysis.

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CASE STUDY IN THE TEACHING OF CHEMISTRY: THE SOIL OF THE COFFEE TREES

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Case study is a method that gives students direct to their own learning and investigating scientific and socioeconomic aspects of real or fictitious situations at various levels. In this method, it is the use of narratives (case) on problems that need to be resolved, which students must make decisions, choices and seek for solutions1. This study aims to evaluate the contribution of the case designed to promote the skills of argumentation. The development stages of the study were: (a.) preparing the case1,2 (b.) application of the case, with 27 second year students of a Brazilian state school (c.) data analysis3. The case addresses the problem of growth of the coffee plantations in regions with soils with pH unsuitable for planting. To solve the problem, materials were given to the students to conduct experimental activities, in an investigative way. For the analysis of student's arguments we used their written records and such analysis were based on the model Toulmin3. Through this model we sought to assess the quality of arguments, considering how students relate the different components of the argument: data collection (D), establishing justifications (J) to reach conclusions (C); if these justifications rely on basic knowledge (B) or not, the use of qualifiers (Q) and refutations (R) during the presentation of arguments. The higher the number of components has been, more elaborate arguments were4. Within this perspective, it was observed that the combination of the "CJB" was used by two groups that do not collect the data or not included in their arguments, which are bases on low chemical knowledge and mostly in basic skills. Arguments like "CDJB" were used by the two remaining groups, which could relate to the three fundamental elements, the data, the conclusion and the rationale and still included the basic knowledge, added with the objective to support the justification. It was observed that all groups showed difficulties in making the distinction between date and rationale, and justification and basic knowledge, and do not present the elements and qualifiers rebuttal, pointing out the difficulty of students to include these compounds in their arguments. In conclusion we can say that the case study method can contribute to the argument, since all group had reasons, characterizing the quality of the arguments5, the method associated with the trial left the students are excited, which, according to the teacher, did not occur with conventional academic material, producing extremely positive results in relation to student learning. Thanks to CNPq, CAPES, FAPEMIG, MEC and Unifal.

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SCIENCE, TECHNOLOGY AND SOCIETY IN INSTRUCTIONAL MATERIALS PRODUCED BY HIGH SCHOOL CHEMISTRY TEACHERS: A CONTENT ANALYSIS

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Taking into account that one of the main goals of science education is to "develop students' capacities to function as responsible savvy citizens in a world increasingly affected by science and technology"1, chemistry curricula in a STS approach ought to be planned to explore chemical concepts in such a way that allows the students to understand and give sense to the physical world. Thus, the teachers' elaboration of their own instructional materials might be a valuable way to meet these goals.

The aim of this work is to analyze context-based units focused on STS approach produced by high school chemistry teachers. These units were produced during an in service course offered to help teachers plan activities considering a STS perspective in the contents and methodologies they judged appropriate to their classes.

The units were classified in one of four approaches2: focus on chemical content using daily life examples related to chemistry concepts; focus on chemical content adding scientific description of processes involving chemistry and society; focus on problems and situations of social relevance, where science content is introduced to facilitate the understanding of the situation and judgment skills by the students; focus on comprehension and transformation of social reality aiming the development of values and the participation of the students in responsible political actions.

Five didactic units produced under the theme of fossil combustibles were analyzed. Aspects like production, efficiency, environmental impacts were addressed in those materials. These units were classified as scientific description of processes since the emphasis was put on chemical content and few concerns were presented on social issues. However, there was an improvement compared to traditional instruction materials focused exclusively on chemical content. Thus, the development of instructional materials seemed to be a good strategy to help teachers to plan context-based teaching.

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IN-SERVICE TRAINING FOR CHEMISTRY TEACHERS IN ADULT EDUCATION UNDER THE FREIREAN PERSPECTIVE

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The function of Adult Education in Brazil (AE-BR) is to guarantee citizens, from any social background, who did not have access to school1 the onthologic right to a high quality continuing basic education. Therefore, beyond the concept of 'lifelong education', as the documents of International Conferences on Adult Education (CONFINTEA/Unesco) put it, in Brazil AE-BR aims to ensure people to come back and attend school, and to conclude basic schooling.

Once AE-BR specially targets adult students, who possess experiential knowledges, AE should adopt a specific teaching method, including in high school Chemistry classes However, as basic education teachers start their activities, they tend to replicate "an Aristotelian empiricist – and even positivist – attitude [...] because teacher formation programs generally do not include epistemological reflections" (MALDANER, 2003, p. 103-105)2. One of the consequences is the adoption of teaching techniques based on memorization of concepts and featured by the lack of contextualization of facts and phenomena.

With the goal of overcome those teachers' deficiencies, continuing training ends up shouldering this responsibility. In this regard, we discuss the purpose of taking the perspective of critical reflection over practice (FREIRE, 2004)3, since "Critically reflecting about current or past practices is how we can perfect the next one" (p. 39). Yet we point out that this can cause complications in the current thought-styles (TS), as put by Fleck (1986)4, which consist in sharing practices, concepts, traditions and rules. When organized on these epistemological tenets and under the dialogic problematizing perspective, continuing formation is able to detect and overcome the frequent dichotomies in Chemistry teaching between theory and practice; common sense and scientific knowledge; "banking" education and liberatory education; on the basis of the conflicts and contradictions of the public school.

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DENSITY AND HOT AIR BALLOONS: CONTEXTUALIZED DIDACTIC PROPOSAL

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Background, framework and purpose. Studies show the importance of showing students that Chemistry leads to the understanding of daily-life phenomena1. While teaching Chemistry contents, it is essential to establish the teaching-and-learning process on the approach for Science, Technology, Society, and Environment (STSE), aiming to development of student citizenship2-3. The objective of this study was to plan and elaborate a contextualized didactic proposal for the teaching of the concept of density, considering experimentation as form of discussion of this subject. Through this proposal, the knowledge of science becomes interesting to the student and he understands its implications in daily life, being able to improve his formation as citizen and empower himself to take decisions on a personal and social dimension4.

Methods. Stages: (a.) Identification of content difficult to understand, by students of the first year of high school; (b.) Picking a theme and experiment for discussion and contextualizing; (c.) Elaboration of pedagogic procedure and teaching activities that consider situations and materials known by students; (d.) Evaluation of the proposal by Chemistry teachers from Brazilian public schools.

Results. This proposal was the result of actions from the Formation Continuation Program for Chemistry Teachers from the Federal University of Alfenas, and was elaborated in collaboration with high school Chemistry teachers. With the participation of the teachers, it was chosen the concept of density and to contextualize, the issue 'rising and falling of hot air balloon' was chosen, since it is explained by this specific function. The experiment led to discussion by using metal parts of Ti, Al, and Stainless Steel, which is characteristic to balloons.

Conclusions and Implications. It was drawn to conclusion that the subject is proper for the teaching of density, allowing to be contextualized, and that discussing the experiment may contribute to the formation of participative students in society.

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TEACHER'S PORTFOLIO IN THE PROFILES CONTEXT: SOME CONCEPTUAL AND METHODOLOGICAL ISSUES

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The focus of the presentation is on teachers' implementation of a new teaching approach – PROFILES – in which teachers are both subjects and objects of their own reflection, by using the portfolio. Namely, in this context the portfolio served for two purposes1: (1) procedural, in order to develop the science teachers' reflection, encourage their professional development and their self-concept, as well as improve the quality of learning and teaching and (2) evaluative, thus being a tool for science teachers to present their pedagogical competences and knowledge of the new professional experiences related to the project goals through the process of action research following the main principles of PROFILES approach (i.e., IBSE through raising the self-concept of science teachers and in so doing aiding a better understanding of the changing purpose of teaching science in schools and the value of stakeholder networking). From follow-up monitoring and partial evaluation of the portfolio2,3 use by the 45 in-service science teachers from Slovenian elementary and secondary schools involved in the PROFILES project we can conclude that the portfolio played a vital role in the first year of the project and had relatively well-performed its function, although this had been for most of the teachers their first portfolio's experience. Beside several identified benefits (e.g., enhancement in reflective teaching approach, sensitivity to students learning needs and motivation, rise in the use of meta-cognitive strategies) we observed also some of the problems, e.g., difficulties expressed directly by the teachers which refer to time management, thinking effort and professional self-concept. On the other hand, certain issues were perceived which arise implicitly from the performed evaluation – teachers involved in the project had a very different knowledge in research theory and psychology of learning and teaching. Nevertheless, on the basis of our first-year PROFILES experience with the portfolio it should be emphasized that the teachers did care about the quality of the teaching process, however, they should not be left unsupported. We believe that teachers are willing to work, to learn and implement innovations in their work with appropriate professional support and in a community that respects their efforts and teaching competence.

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PROMOTING INQUIRY-BASED PRACTICAL CHEMISTRY USING SOLO TAXONOMY

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Educational design research is a systematic study of designing, developing and evaluating educational programs, processes and products (Edelson, 2002). The aim of design is a supplementary training course that promotes inquiry-based approach in practical chemistry instruction at the upper secondary level. According to preliminary research, a prototype of a voluntary supplementary training course was planned and carried out for twelve in-service high school chemistry teachers lasting for three months. It included two days of contact lessons and workshops, namely one Saturday in the beginning and one Saturday in the end of the course. Between two meetings the researcher was tutoring for one week in the internet learning environment which was built for information exchange and mutual support between meetings. In the beginning teachers were introduced the SOLO (= Structure of the Observed Learning Outcome) taxonomy (Biggs & Collis, 1982) as a tool to evaluate the quality of written instructions found in the chemistry books from which teachers prefer choosing assignments for practical lessons. Teachers were also introduced the action research methodology to investigate the results of their actions in the classroom. All the participants answered to the questionnaire afterwards. Four teachers were interviewed and the results were obtained using qualitative content analysis. It came evident during interviews that teachers are reluctant to use inquiry approach in practical chemistry because it takes too much time from content coverage and practical chemistry plays only a minor part in matriculation examination. The experiences during the first case study led to changes in the second implementation of the course: firstly, teachers did not actively participate in the learning environment and secondly, the amount of collaborative tasks was increased by adding a third day for contact meeting. I shall discuss the results obtained from the first design experiment.

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MOTIVATING CLASSROOM TEACHERS INTO HANDS-ON SCIENCE EXPERIMENTS IN PRIMARY SCHOOL SCIENCE EDUCATION

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Keywords: Experimental work, classroom teachers, continuing education, inquiry-based studying, primary school

One of the nation-wide education goals in Finland in science education is to create interest and enthusiasm about natural sciences by first-hand experiences of scientific inquiries and experimenting. Nonetheless, it seems that primary school science education – especially the chemistry and physics education at fifth and sixth grade could involve more experimental and scientific inquiries than realized in schools. Based on feedback from classroom teachers their involvement and applying of experimental work in classroom is limited. Reasons for this may be the narrow experience and unfamiliarity of easy and simple chemistry and physics experiments by the teachers, which reflects the fact that a minor number of classroom teachers actually specialize in science education during their education. Training and motivating in-field classroom teachers into hands-on experiments and inquiries are chosen focus areas at the Central Finland science and mathematics resource centre (LUMA-KS), which as a member of the nationwide network targets in motivating and enhancing interest and knowledge of natural sciences, mathematics and technology of students and teachers on all levels of educational system. The main objectives for the support project of classroom teachers started in 2011 are to strengthen the role of experimental work in chemistry and physics teaching and to help teachers to realize how everyday phenomena are related to chemistry and physics and how the science behind them can be used in science education making it interesting and enchanting. Moreover, the project concentrates on demonstrating and training the teachers of easy-to-use, non-hazardous and inexpensive experiments. The training of teachers take place on location in the classrooms of the teachers with their own students. This is directed to show the teachers first-hands how the experiments work, how they can be applied in the classroom and even give the teachers the possibility to experiment themselves with scientific and pedagogic support present. A total of 85 on location visits in various primary schools were organized during 2011. The visits, their content and views of both the teachers and the students were collected after the visits by a questionnaire. The survey data gathered contained only open questions and the data collected can be considered only qualitative in nature. Nevertheless, the study will provide information about the classroom teachers' and students' perceptions and experiences of experimental chemistry and physics studies performed. Especially the classroom teachers have strongly expressed the need for such on-location training as well as the possibility of expert assistance and support both during the training as well as afterwards. As the main outcome, the classroom teachers have adopted scientific experiments and inquiry-based approach in their teaching. Some of the teachers have been so impressed by the enthusiasm of their students that they have extended the experimental repertoire beyond that provided to them in the training. The university experts have been mentoring the teachers in their own development projects.

In this presentation, some of the experimental approaches used in the training are presented. Also, some findings and analysis of the feedback from the training is presented.

SUSTAINABILITY INTO CURRICULA DESIGN FOR SOLAR ENERGY

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Sustainability is one of the most needed issues in our educational system. Solar energy can play an important role in this matter. Our report focuses on designs of teaching modules for chemical conception change on solar energy. A reading comprehension test to the pupils was used to understand the differences between before and after our teaching experiments. From those hands on activities, such as sunlight only, brightness matter, our fifth grade subjects could build up their own understandings concerning solar energy. Our results show their understandings are as follows: a. solar energy includes visible (VIS) and invisible lights. b. most of thermal energy and/or heat from the sunlight is transferred via the irradiation of visible light. c. in invisible regime, the existence and characteristics of ultraviolet (UV) light. However, after teaching experiments with interviews, our subjects still had some misconception concerning UV, such as heating effect upon irradiation and its subsequent outcomes. Suggestions to the teaching and learning solar energy in elementary school level are provided regarding the misconception of the issue.

Keywords: conceptual change, hands on, solar energy, teaching module, UV-VIS light.

PLANNING INQUIRY-BASED EXPERIMENTAL ACTIVITIES: A PROCESS OF ORIENTED REFLECTION EXPERIENCED BY HIGH SCHOOL CHEMISTRY TEACHERS

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Chemistry teachers generally assumed that laboratory activities are essential to teaching. However, they apply traditional approaches that focus on verifying knowledge already presented in class and they employ highly structured procedures, which often lead to poorly student participation1. Taking into account the limitation of these kind of practical activities, and considering that some teachers have difficulties to critically analyze their own teaching practices2, this study investigated how a oriented reflection process helps teachers to reflect on and evaluate their teaching practices. An in-service course centered on practical activities as a resource to promote learning, was offered to 12 chemistry teachers of high schools of the city of Uberlandia, Brazil. During the whole school year collective meetings as well as individual ones occurred between the teachers and the researcher (V.A. L.). In these meetings, the teachers were invited to analyze their own experimental classes as well as those of the peers. Inquiry-based activities were provided to be compared to traditional ones, the teachers experienced formulating questions aimed to help students achieve the answer to a proposed problem and to promote higher order cognitive skills4. The teachers rewrote their teaching plans considering inquiry-based approach, which were discussed by the group and suggestions of modifications were presented.

At the beginning of the course the teachers showed a narrow perspective of the role of laboratory activities aimed to motivate the students and show experimental evidence of theories already taught. Nevertheless, the teachers realized that some of the changes they provided in laboratory practices enhanced students' engagement in the activities and a higher level of learning was achieved. The teachers claimed they had difficulties in proposing inquiry-based activities and in posing questions. They believed they had overcome some of these difficulties due to the oriented reflection process as well as the process of sharing pedagogical experiences. They considered the activities useful to apply in classroom, either in relation to the concepts treated or in relation to the proposed procedures.

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COMMON AND TECHNICAL LANGUAGE SUPPORT FOR HEARING-IMPAIRED LEARNERS IN CHEMISTRY CLASSES

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Promoting communication and language skills has been accepted as a challenge in Science and Science Teaching [1, 2]. So far, language training of deaf and hard-of-hearing learners in chemistry classes was not considered sufficiently. The language support in classes with hearing-impaired learners is a special challenge as their common language skills are usually very restricted [3]. Deficiencies often concern both spoken and written language. Due to this problem, there are also deficiencies in technical language. Writing in science classes is an essential means for structuring knowledge to enhance learning processes [4]. Therefore, it is necessary to think about concepts to promote common and technical language skills.

Based on the concept of Participatory Action Research [5], methods to support student's ability to report experiments are tested and evaluated in chemistry classes. In this project specific language requirements of hearing-impaired students as well as methodological tools and concepts of language support [6, 7] will be considered. In order to develop a language promoting program, interviews and survey studies among special education teachers and outcomes of a video study were used. The findings will be reported and discussed in the presentation.

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DEVELOPMENT AND VALIDATION OF A PAPER-PENCIL TEST REGARDING COMMUNICATION OF CHEMICAL INFORMATION

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The study is based on the German National Educational Standards in chemistry1 at the end of grade 9 (15 y/o students). These standards are evaluated and enhanced by the Institute for Educational Progress in a national project called ‘Evaluation of the standards in natural sciences’ (ESNaS)2. The standards name four areas of competence: Application of content knowledge, Acquirement of knowledge, communication and evaluation and judgement. The project presented here focuses mainly on the communication competence. The first aim is to adapt a model of competence, which has already been used for the evaluation of the three other areas of competence for measuring communication competence. The second aim is to identify in which way the competences communication and application of content knowledge and furthermore the competences communication and evaluation and judgement are empirically connected. The first connection is basically expected because the standards mention the ability of dealing with chemical content in both areas. In one case the focus is on the process of accessing and conveying chemical content (communication) while in the other case the focus is on understanding the content itself (application of content knowledge). The other expected connection is the assumed link between communication and evaluation and judgement. Since communication competence includes argumentation and evaluation and judgement requires scientific reasoning, it is expected that students’ abilities are correlated in both areas of competence.

To collect data, different test items will be developed, validated and administered for the assessment of 540 students in Germany. After the data collection a Rasch analysis will be calculated to estimate the item difficulty and the person parameters. Furthermore, structural equation models will be calculated to identify the relations between the areas of competence communication and a) application of content knowledge and b) evaluation and judgement.

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THE DYNAMICS OF AN AFRICAN CHEMISTRY CLASSROOM PRESENTATION EXPERIENCE:

THE CASE OF A KENYA CLASS TEACHING

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Teaching is an exciting game especially if classroom discussions are moved to high levels of student excitement by a dynamic teacher-student exchange. Forging favorable questioning styles involving two way discussion inter-change is a skill vital for effective communication in a chemistry classroom. This needs tact which can be observed in a reach live classroom situation. Teacher training in Kenya, like everywhere else puts an emphasis in this because this approach in teaching produces a rich classroom interchange with an emphasis in student-centered learning environment.

This which will be presented in the conference will share a classroom in experience in an African context observed in a live Kenyan Chemistry Classroom situation. Part of the paper will include the training approach used and share the match or the mismatch between the training exposure and the practical presentation in a live chemistry classroom.

EDUCATION FOR SUSTAINABILITY

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Numerous solutions, which have caused a lot of damage to the environment, were based on the erroneous behavioral stereotypes due to thoughtlessness or lack of knowledge. If anyone knows that his/her behavior may ruin the base of existence both for the person itself and for others, including the nearest and dearest, there is a strong reason to suppose that such behavior will be changed. The same can be expected from governments and countries: there is a need for activity on a national level involving authorities and states.

The biosphere must be considered as an integrated system. It's important to understand that any kind of action, even the most insignificant one, has its consequences. That requires decision-makers, leaders and chiefs to estimate possible consequences in advance. Each person must be responsible for own deeds and deeds of others, for the humanity and the biosphere as a whole. Such responsibility should base on knowledge that should be learned the sooner the better. The perception of the world as a sophisticated system must be inculcated in kids and strengthened during long-term education.

All the first- and second-year students from all faculties of D. Mendeleev University of Chemical Technology of Russia study special discipline – Problems of Sustainable Development. The course content was thoroughly elaborated, approved many times and supported by didactic materials. The course has interdisciplinary nature and includes a whole range of sections from different scientific areas: chemistry, physics, philosophy, ethics, demography, sociology, biology, ecology, law, economics etc. Course objectives are: to teach the students a holistic paradigm, to help them understand the environment as extremely complicated and interrelated system, to realize the role of human beings as a part of it, to give an idea of how crucial the consequences of anthropogenic influence on the environment can be, to teach them system thinking.

Complicated interdisciplinary nature of education for sustainable development requires students to combine global and regional view with personal and group activities for problem solving. The course uses different tools to achieve this goal: active educational methods, role-playing seminar for joint decision-making, "Worldwide fishing" imitation game for renewable recourses managing, educational videos etc. "Stratagem" net imitation game for state management is a mandatory part of the course; all the students take part in it to study the technique of decision-making and how to take into account the short-term and long-term consequences for the economy, the environment, the country and the globe.

All these issues are subject of investigation for scientific staff of the Institute of Chemistry and the Problems of Sustainable Development. The Institute was created on the base of D. Mendeleev University of Chemical Technology of Russia; now it operates as University's faculty, where highly qualified faculty members, lecturers and scientists combine scientific activity with teaching future specialists at the following departments and higher colleges:

Higher College for Rational Use of Natural Resources

Higher Chemical College of Russian Academy of Sciences

Department of Problems of Sustainable Development

Department of Life Safety

Department of Sociology

Higher School of Environmental Sciences

Department of the Megalopolis Ecology

Department of the Natural Resources Management

We consider general education for sustainable development as a key way to prevent global crisis and help the humanity to live in harmony with the environment.

HOW MUCH COMPETENT ARE PRE-SERVICE CHEMISTRY TEACHERS IN DETERMINING STUDENTS' ALTERNATIVE CONCEPTIONS?

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Many students find chemistry difficult due to the abstract nature of its concepts. Past research has shown that students' conceptions are often inconsistent with the scientific conceptions they are expected to learn [1, 2, & 3]. Allen (4) stated that if teachers are unaware of alternative conceptions associated with a particular concept, they might overlook them. So, it's important to make pre-service teachers being aware of students' and their own alternative conceptions. The main goal of this study was to investigate the competency of pre-service chemistry teachers in determining students' alternative conceptions, and the subordinate goal was to trial an alternative method to uncover pre-service teachers' alternative conceptions. For achieving this, a two-step procedure was utilized. In the first step, a concept test, consisting of open-ended questions, developed by the researchers was administered to 465 12th grade students. The students' responses to this test were analyzed and several alternative conceptions related to the concepts under investigation (particulate nature of matter, nature of chemical equilibrium, and strength and concentration of acids) were identified. Then, some interesting students' responses were selected for use in the next step. Teacher versions of this test consisting of original (with their hand writing and drawings) student responses (some were scientific, some were alternative) were formed. In the second step, these were given to 15 pre-service chemistry teachers and they were asked to evaluate students' responses (scientific, alternative or mixed) to the questions on the test. The pre-service teachers' evaluations are now being analyzed qualitatively to understand their competency in determining students' alternative conceptions. By using such a two step procedure, it's thought that it will be possible both to understand pre-service teachers' competency in the identification of students' alternative conceptions, and to reveal teachers' own alternative conceptions. The findings and their implications for chemistry teacher education will be shared and discussed in the conference presentation.

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THE PEDAGOGICAL CONTENT KNOWLEDGE OF HIGH SCHOOL CHEMISTRY TEACHERS ON ACIDS AND BASIS CONCEPT

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This study examines the characterization of the Pedagogical Content Knowledge (PCK) on acids and basis of ten Mexican high school chemistry teachers.

According to Shulman1, teachers develop a body of knowledge about teaching the content, PCK, which is specific to each subject, is elaborated personally in the course of their teaching practice, distinguishes teaching as a profession, and is a form of reasoning and pedagogical action by means of which they transform the content of the subject into representations that are comprehensible to their students. Loughran2 et al., presented a framework questionnaire called Content Representation (CoRe). In this study a modified CoRe has been applied.

Firstly, personal interviews were performed with each participating teacher. Through the interviews analysis, we have extracted eight central ideas on the concept of acids and bases: acid and base concepts; pH / strength of acids and bases; neutralization reaction; concentration; Bronsted-Lowry model; Arrhenius model; autodissociation of water; acid-base equilibrium. Taking these central ideas, a modified CoRe was applied to each participating teacher. Special emphasis was put in getting the teaching strategies. The questions planned in the CoRe designed were: What do you intend students to learn about this idea? Why it is important for them to know this?; What background must students know to adequately comprehend this idea?; What knowledge on history, epistemology and philosophy of this idea must be developed while teaching?, What aspects of everyday context are important to teach this idea?, Which are the difficulties connected with teaching and learning this idea?, What knowledge about students' conceptual, procedural and attitudinal troubles influence your teaching of this idea?, What teaching procedures and resources (analogies, metaphors, examples, videos, demonstrations, simulations, practical activities, etc.) are used to engage this idea?, What are your specific ways of ascertaining students' understanding around this idea?. Finally, with the information collected, a characterization of PCK of each teacher was established.

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UTILISING AN EXISTING PCK INSTRUMENT TO CAPTURE AND DEVELOP IRISH PRE-SERVICE TEACHERS PCK TOWARDS AN INQUIRY ORIENTED FOCUS

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This longitudinal study involves the utilising and adaption of an existing Pedagogical Content Knowledge (PCK) instrument to capture and develop pre-service teachers topic specific PCK with a specific focus on inquiry based practice. PCK is an amalgam of knowledge of content and pedagogical (Loughran et al 20061) and is a knowledge unique to teachers. Inquiry based practice has been highlighted in literature as being an effective teaching strategy towards aiding students' motivation and achievement levels in science (Wilson et al 20103). However, it has been emphasised that there is a seemingly lack of inquiry practice within European schools from the current research (Rocard Report 20072). There are a number of projects currently being disseminated (Fibonacci Project) which looks at the dissemination of inquiry based practice through professional development of teachers. However a baseline does not exist which looks at the habitus of teachers (in-service or pre-service) towards an inquiry oriented practice. Therefore, the purpose of this study is to capture and portray the PCK of Irish pre-service teachers (n=11) as they engage in their Science Education Degree whilst concurrently examining their inquiry habitus and how it develops through their participation in this study. The research tool used is a PCK instrument which has been developed by Loughran et al (2006) which captures and portrays the general PCK of the participants involved in a focus group setting. This instrument, known as Content Representation (CoRe) has been adapted slightly to allow for a more inquiry oriented focus. The focus group consists of the participants developing the "Big Ideas" around a particular topic, ideas that help in the understanding of the topic. The researcher then asks a number of framed questions which expands on the big ideas and draws out the PCK of the participants. Through discussion in the focus group, participants are able to share ideas using the prompts from the framed questions. Since the adaption of this instrument, the participants are more inclined to not only think through inquiry but refer to the different levels of inquiry in their thinking. This suggests that involvement in this study has developed their habitus towards an inquiry focus. This has been verified by semi structured interviews with the participants where they have shared a number of benefits to the inclusion in these PCK sessions- including orientation to inquiry practice. Through involvement in these CoRe sessions where ideas are shared, they develop the ability to think of inquiry activities more readily as these ideas are being drawn out of the habitus of the teacher through the development of the "Big Ideas" and subsequent expansion of the big ideas by answering the framed questions. The results so far show that the CoRe instrument can be used to capture and develop elements of inquiry in the PCK of the participant. Actions of the participants will be identified when they are on Teaching Practice in their final year however the results so far clearly show that through involvement in these focus groups, participants are engaging in professional development towards more inquiry oriented thinking. Also by having a record of their existing PCK, this allows participants to see the stage they are at in their development towards becoming competent facilitator of learning.

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RELATING COURSE THEORY TO SCHOOL PRACTISE – A STUDY OF SCIENCE STUDENT TEACHERS LEARNING

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The study focus on 25 science student teacher's participating in short (1½ year) teacher training program in our University. The students had completed their subject studies earlier, perhaps in another education program, and by adding this course they would be qualified secondary teachers. Since the students already achieved their subject matter knowledge (SMK), the focus of the course is general pedagogy (PK) and science education in order to increase the students' pedagogical content knowledge (PCK). Within the course several periods of teaching practice is included. In their practice the students should become aware of critical events in the classroom. A critical event is a specific situation in a lesson that is critical or significant for the student, and evokes their concerns, questions or needs for support for learning how to teach science1. Critical Incidents has been used successfully to help student teacher focus on the problematic nature of teaching2. In self reflection and discussions with peers and educators about these incidents, student teachers might explicit their concerns for teaching and needs for learning.

General research question: To what extent does the Teacher education course help student teachers to overcome these concerns and to fulfil their needs for learning?

The method used is teacher student self reporting about their lesson observations and/or about their teaching in terms of: a) Critical events, b) Evoked concerns and c) Needs for learning. In the report, a critical event should deal with teaching and learning specific science topics, no general issues like 'law and order' in the classroom. In addition, two workshops were included in the data collection were the students discussions about their experiences were recorded.

The Teacher students expressed that they felt comfortable with their Subject Matter Knowledge (SMK), however, they expressed needs for teaching strategies for i) explaining difficult concepts but also for ii) motivating and enthusiasm their pupils. They were also surprised over some of the pupils' preconceptions and difficulties. Knowledge of teaching strategies and students' difficulties are the two major parts of Pedagogical Content Knowledge (PCK)3. Further, some students asked for all set lectures, explanations and arguments for motivation. These statements might indicate that the teacher students weren't so comfortable with their SMK as they felt.

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HIGH SCHOOL CHEMISTRY TEACHERS' MISCONCEPTIONS ON ATOMIC ORBITAL: INVESTIGATION AND IMPLICATIONS FOR DEVELOPING CHEMISTRY TEXTBOOKS

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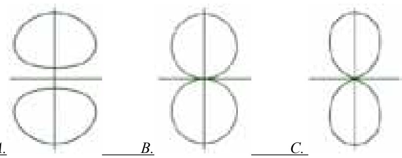
Atomic structure is a potential threshold concept for study in science(1), and the similar troublesomeness will be encountered by teachers. This study investigates 3833 high school chemistry teachers in China, and the result shows general misunderstanding on atomic orbital. For example, When participants were asked to point out which picture as follows was more better to show contour lines of probability density of 2p orbital. Most teachers (64.2%) chose C (polar plot of $(\psi_{2p})^2$) as their answer. There are only 17.3% teachers choosing the right answer A (contour lines of $(\psi_{2p})^2$). As well as 7.2% teachers chose B (polar plot of ψ_{2p}), 2.0% teachers chose "none of above" and a lot of teachers (9.0%) expressed that "I don't know".



A. *B.* *C.*

It is misunderstanding to take Fig.C, which is printed in most chemistry textbooks, as "the probability of finding the electron in space" (i.e. the space distribution of the electronic density), or "a region of high electron charge density", or similar expression(2-4). Some other misconceptions on atomic and molecular structure reflected from our investigation are also discussed.

The most important source of misconceptions is that the majority of high school chemistry textbooks and university textbooks of General Chemistry just present figure of polar plot of $(\psi_{2p})^2$ and might point out the shape shows where electrons are likely distributed in a misleading way. Some textbooks present figure of one 2s orbital and three 2p orbitals superposing together, which will result in misunderstanding that 2p orbital's radii is much larger than 2s orbital. We suggest the nature of atomic orbital(4) should be interpreted clearly in chemistry textbook, as well as different models should be presented, such as linear contour maps, electron cloud of p orbital and hybridized orbital, etc..

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DEVELOPING A TEST INSTRUMENT FOR ANALYZING COMMUNICATION PROCESSES IN CHEMISTRY EDUCATION

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Reviewing literature on teachers' professional knowledge one can find that the dimension of pedagogical content knowledge (PCK) is particularly emphasized and became a focus for current research.1 Two facets can be seen as key elements of PCK: knowledge of representations and knowledge of students' pre- and misconceptions.2 This study is solely concerned with students' pre- and misconceptions and how teachers deal with them in real classroom situations in order to gain deeper insight into the relation between teachers' professional knowledge and their behaviour during instruction. Given that classroom communication can influence students'understanding3 this study is predominantly concerned with the analysis of communication patterns in chemistry lessons. For this purpose, a theory-driven category system based on the standards of content analysis4 is being developed. The basic assumption is that chemistry teachers who offer their students the chance to provide rationale for their statements have the opportunity to learn about their students' pre- and misconceptions or the other way round. Therefore 25 videos of chemistry lessons are analysed with the help of communication process diagrams. First results give a hint that communication processes in higher grades are less elaborated than those in lower grades. Providing instruction that takes students' misconceptions into account was barely possible, because extensive student-student and student-teacher discussions were not fostered. At the moment, 40 videos of chemistry teachers are videotaped in different grades, in order to increase data basis. Both, examples of our newly developed communication process instrument and recent results will be presented in July 2012.

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DEVELOPMENT OF EXPERIMENTAL PROGRAM FOR ACQUISITION OF MOLE CONCEPT

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Mole concept is applicable fundamental concept in chemistry to clarify the changes of the phenomena. However, instruction by teacher and understanding of the concept requires so much effort. Therefore, many studies were carried out.1 Two aspects exist in the concept as a “number” and an “index”. Most reports focus on one aspect of those. We developed an experimental program being integrated both aspects.

A survey of present educational-research on “mole” was conducted, and related experiments were extracted and classified on the bases of the two aspects. Step with targets of attainments were set and corresponding contents of study were selected. Packing module2 type of experimental program was developed including, e.g. “Change of state in ethanol” of 4th grade (g4), “Determination of Avogadro constant, NA, with crystalline NaCl ” (g11), and “Calculation in real gas” (g13) as shown in Scheme 1. The program was composed of the text for experiments, experimental materials, background information, and explanatory power point file. The text was taken into consideration of insertion of numerous photographs in order for student himself to be able do each experiment smoothly.

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DEVELOPMENT OF PRE-SERVICE CHEMISTRY TEACHERS' SCIENCE TEACHING ORIENTATIONS IN PRACTICE TEACHING COURSE

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Science teaching orientation (STO) is an important component of pedagogical content knowledge1,2 (PCK) because it influences teachers' practice through shaping other PCK components3. Considering the essential role of STO in instruction, there is a need for empirical studies delving into the complexities of nature and sources of STO3.Therefore, the purpose of this study was to investigate the development of pre-service chemistry teachers' STO in a practice teaching course, sources influencing their STO during the course, and how these student teachers reflected their STO to lesson planning and instruction. Three pre-service chemistry teachers enrolled the course and represented the information rich cases were selected as the participants. The practice teaching course was grounded on the PCK framework2. Participants received one-to-one mentoring throughout the course as they plan their lessons for microteachings at the faculty of education and instrucions in the co-operating high schools. Lesson plans and semi-structured interviews were used as data collection sources. We defined STO as a set of beliefs including goals and purposes of science teaching, views of science, and beliefs about science teaching and learning3. In terms of the beliefs about science teaching and learning, all three participants viewed themselves as learners; assigned active role to students and guide or facilitator role to teachers, and their beliefs remained constant throughout the semester. In views of science dimension, all the three viewed science as a process of inquiry with the aim of producing knowledge and there was no change as well. With regard to goals and purposes of science teaching, they were thinking to teach for solid foundation, everyday coping, self as explainer, interest in chemistry, correct explanation, and scientific skill development at the beginning of the course and they added teaching for nature of science at the end. The degree to which lesson plans reflect participants' STO gradually increased throughout the practice teaching course with the contribution of participants' self-awareness of their STO and internalization of PCK framework. Considering that the course was the first context where the participants were introduced with PCK and mentoring, changes in pre-service teachers' STO might be attributed to PCK framework and one-to-one mentoring which lead to reflection on their STO.

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BRAZIL-PORTUGAL INTERNATIONAL PRE-SERVICE FORMATION INTERCHANGE: THE VISION OF BRAZILIAN CHEMISTRY STUDENTS AT THE UNIVERSITY OF COIMBRA

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The results obtained by Brazilian secondary school students in international evaluations such as PISA1 show that, despite the economical growth of Brazil in the last ten years, there are crucial educational problems that must be solved in order to promote a more equilibrated development of Brazilian society. In order to deal with these educational problems, the Brazilian government established an interchange program with the University of Coimbra, in which Brazilian pre-service students would receive a financial grant to stay in this Portuguese institution for two years. The main objective of the Brazilian Education Ministry with this program is to develop a new generation of secondary school teachers with an international formation, a better cultural background, a deeper comprehension of the educational process and a higher self-esteem.

At the moment, there are forty Chemistry pre-service Brazilian students at the University of Coimbra, with ages around 20 years-old, since only second and third term pre-service students are allowed to take part of this program. The first group, which started at the University of Coimbra in 2010, will return to Brazil by the end of 2012. In order to evaluate the views of the group of Brazilian Chemistry pre-service students about this interchange experience, three of these students developed, together with their Brazilian supervisor, a short questionnaire that was answered by 50% of this group. The analysis of the answers showed us that most of the interviewed students are facing problems with disciplines involving abilities related to Mathematics, such as Physical Chemistry and Theoretical Structural Chemistry, and most of them have failed in at least one discipline. They feel that the so-called pedagogic disciplines are contributing positively to their formation, and they also believe that their stay at the University of Coimbra would help them to be better in-service teachers. On the other side, only one of the interviewed students said that teaching is in his future professional plans, and even in this case, his aim is to be a third-level lecturer. The other students wish to work in basic Chemistry research. The lack of interest in being second-level in-service teachers may be due to the low incomes of Brazilian teachers, the poor educational resources of the Brazilian public schools and the increase in the salaries of the chemists working at Brazilian industries, especially those of the petrochemical field.

OECD Programme for International Student Assessment (PISA), http://www.pisa.oecd.org.

PRE-SERVICE CHEMISTRY TEACHERS' INSTRUCTIONAL DESIGNS OF 5E LEARNING CYCLE MODEL ON INTERMOLECULAR FORCES

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Constructivist teaching strategies (CTS) have a significant role in conceptual change and meaningful learning in science education 1, 2, 3. One of the most common CTS is 5E learning cycle model (LCM). It enables students to remove their misconceptions and construct scientific concepts using their prior conceptions4, 5. Research studies have indicated that instruction based on 5E model causes a significantly better acquisition of concepts than traditional instruction 6, 7. Therefore, pre-service teachers should have sufficient knowledge about CTS like 5E model and apply these strategies in their teaching practice. One of the difficult chemistry topics for students is intermolecular forces due to the abstract nature and unfamiliar terminology 8, 9. In order to promote meaningful learning on intermolecular forces, teachers should use student-centered teaching strategies in their instructions. Therefore, we examined how pre-service chemistry teachers instruct intermolecular forces by using 5E LCM. Data were collected from seven pre-service chemistry teachers through an open ended question developed by the researchers. In the question, participants were asked to design an instruction on the intermolecular forces by using 5E model and to explain each step and the concepts in detail. Results indicated that while all pre-service chemistry teachers knew all stages of the 5E LCM, they possessed insufficient knowledge about what to do in these stages, especially in exploration stage. Although all pre-service chemistry teachers explained the concepts of intermolecular forces in detail, they could not integrate their knowledge into constructivist instruction; they only used lecturing method. Moreover, none of the participants evaluated the whole instruction process; they only assessed student learning at the end of the instruction. Considering these results, it can be suggested that educators should provide pre-service teachers more opportunity to implement CTS.

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PRE-SERVICE CHEMISTRY TEACHERS' PERCEPTIONS ON MENTORS' PRACTICES

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Pre-service teachers need to improve their theoretical and practical knowledge and abilities about teaching to improve their teaching quality during teacher education program. To improve pre-service teachers' learning how to teach during their practice teaching, "mentor teachers" who supervise them have an important role1. In teacher education program, practice teaching is considered as one of the most important part of pre-service teachers' professional development. In order to improve professional development in pre-service teachers, there is a need to establish interaction between school placement and teacher education programs and pre-service teachers2. Related literature on school practice procedure indicated that mentors have an important role in the teacher education program3,4. Even though current pre-service teachers state the importance of influence of their mentor teachers, pre-service teachers' perceptions about mentors are not clear5. Therefore, the purpose of this study is to investigate the final-year pre-service chemistry teachers' perceptions about their mentors for effective mentoring. Pre-service chemistry teachers who fulfilled teaching practice course were our participants. Throughout the course, pre-service teachers study with mentors at the school placement. Data were collected from ten pre-service chemistry teachers through "Mentoring for Effective Primary Science Teaching" (MEPST) questionnaire, open-ended questions and semi-structured interviews at the end of the semester. The questionnaire, developed by Hudson and Skamp6, consisting of five factors that are personal attributes, system requirements, pedagogical knowledge, modelling and feedback. Data were coded by three researchers to ensure reliability. The results of this study showed that pre-service teachers thought that mentors were supportive and instilled positive attitude in them towards teaching chemistry. Regarding system requirement, their mentors did not provide knowledge related to aims of teaching and education system during the teaching practice course. Similarly, concerning pedagogical knowledge factor, according to pre-service teachers' perceptions, mentors could not assist them in planning, classroom management strategies, and assessment techniques. Finally, for feedback factor, pre-service teachers thought that the feedbacks given concerning their teaching practices by the mentors were not satisfactory. In conclusion, for effective mentoring practices, mentors should be trained.

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SCIENTIFIC ARGUMENTATION WITH PRE-SERVICE CHEMISTRY TEACHERS

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An important feature of science learning is the construction and evaluation of scientific knowledge by using tools which includes the generation of knowledge about the real world. Argumentation is a crucial tool in the growth of scientific knowledge as a form scientific discourse. Since the argumentation is a central aspect of science teaching, over the last decade researchers have gave importance to promote argumentation in science classrooms and support students to evaluate and critique the process, and products of inquiry1. Students in an argumentation process support each other for high quality arguments and show improvement in their interpretation and conceptual understanding of science (Erduran, Simon, & Osborne, 2004). Therefore, in science teaching, pre-service teachers should not be only supported teaching and learning of scientific argumentation in science classrooms, but also should be taught to design and evaluate learning environments. The focus of this research is to investigate pre-service chemistry teachers' qualitative and quantitative contributions to scientific argumentation and their conceptual understanding. Data were collected by written argumentation activities designed to investigate pre-service chemistry teachers' conceptual understanding of a range of aspects of chemistry and audio recording during argumentation. This study was carried out by 27, 4th pre-service chemistry education students for 12 weeks period. Argumentation analyses as qualitative and quantitative were done by using Toulmin's Argumentation Pattern. The results of study showed that pre-service chemistry teachers' conceptual understanding and scientific argumentation quality can improve by promoting argumentation in learning environment.

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INVESTIGATING PRESERVICE CHEMISTRY TEACHERS' REFLECTIVE THINKING ABOUT INSTRUCTIONAL METHODS USING ACTIVITY-BASED INSTRUCTION IN SCIENCE METHODS COURSE

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Many studies in science education have used the reflection as a tool for understanding professional development of inservice and preservice science teachers.1,2,3 The reflective process involves inservice and preservice science teachers looking back at earlier experiences and engaging in a reflective interchange about situations that arise during teacher training.4 The purpose of this study was to investigate the reflections of preservice chemistry teachers about instruction methods for teaching science and especially chemistry in an activity-based science methods course. Throughout the course, the instruction methods such as individual-competitive-cooperative learning, inquiry, argumentation, argumentation-driven inquiry, concept mapping, problem-based learning and project-based learning were used for designing activities by the researchers. Preservice chemistry teachers were asked to participate in activities like a high school student and then they were asked to discuss and reflect about the instruction methods which were used in the activities for example; what is the role of the teacher and learners in this method? What are the strengths and weaknesses of this method and suggestions for improvements? Do you think that you will use this method in the future in your classroom?. The science method course was conducted in two semesters and 31 preservice chemistry teachers participated. Data sources for gaining reflections of preservice chemistry teachers included interviews, written reflections, video records of lessons and researchers' journals. The analysis of the reflections indicated that activity-based instruction enabled preservice chemistry teachers to think reflectively about instruction methods and examine the effectiveness of the developed activities and thus contributed the development of their pedagogic content knowledge for teaching chemistry.

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THE USE OF MEDICINE: FOURTH GRADERS' PERCEPTIONS

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Using medicines is a common activity for almost everybody and many people have negative expectations or even fear in relation to their use (Menacker et al. 1999, Hämeen-Anttila et al. 2008). However, medicine education is not about scaring children, urging them to use more medicines, or using them independently, it is about learning an everyday life skill before becoming personally responsible for one's own health. It is a part of school chemistry, biology and health education. This study aims to clarify fourth graders' (N=51, age 10) perceptions about the use of medicines. The data has been collected using a questionnaire constructed together with pharmacists, teacher educators and teachers and is based on the principles of medicine education (Hämeen-Anttila 2006). Pupils were also asked to draw a medicine cabinet.

Pupils most frequently perceived that the purpose of medicines is to treat a headache, listing several over-the-counter (OTC) medicines (i.e., medicines bought from a pharmacy without a doctor's prescription), also that they could be used in the case of wounds or temporarily when they are sick or have some pain. Chronic diseases were pointed out only in a few cases. Pupils got information about medicines from the pharmacist, the Internet, the physician as well as from medical package; medicines help to ease symptoms and speed recovery. About half of the pupils perceived that with some limitations children can take the same medicines as adults, also that children over 11 may, without parents' supervision, take medicines for minor illnesses. If the medicine does not help, pupils perceived that one should go to the physician. A typical medicine cabinet included OTC-medicines such as painkillers, medicines for coughs and colds as well as first aid equipment. Pupils mainly drew medical packages which included the label of the product.

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DEVELOPMENT OF STUDENT TEACHERS' PROFESSİONAL KNOWLEDGE İN CHEMİSTRY

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Teachers' professional knowledge is considered as a fundamental precondition to enhance students' understanding and learning.1 According to the definition of Baumert et al. (2010), professional knowledge can be divided into three common dimensions: Content knowledge (CK), pedagogical content knowledge (PCK), and pedagogical knowledge (PK).2

Recent studies highlight the positive effect of teacher training at universities (1st phase of teacher education) on the development of professional knowledge.3 In Germany this phase is followed by a 2-year teacher training (2nd phase) organized by a teacher training institute, subdivided into two parts. While the first part of teacher training (2nd phase) focuses mainly on a theory-based instruction of teaching knowledge, the second part emphasizes the teacher trainees' teaching practice. Its impact is hardly evaluated. Especially the influence of different educational backgrounds on the CK and PCK in chemistry is rarely analyzed. The development of teachers' professional knowledge is influenced by several factors. Two of the central indicators are the quantity and quality of the learning opportunities that student teachers have in both educational phases.

Focusing on chemistry specific content knowledge and pedagogical content knowledge, this study follows 130 student teachers during their 2nd phase of teacher education program. Concerning the educational background of student teachers, a distinction into three different subsamples is realizable. The differentiation between non-intensified and intensified student teachers is due to different university courses needed to become a teacher at different secondary school types. Both student teacher groups pass a traditional teacher education program at university whereas non-educational students without any university teacher education during their 1st phase also have the opportunity to become teachers (e.g. certificated chemists, who have worked in a company for several years). Thus, we have measured the CK and PCK by means of a paper/pencil test during the 1st part of their teacher training. By pairwise comparisons with t-tests for independent samples, differences in the state of knowledge between the three groups have been revealed. The comparisons in content knowledge between the first and second point of measurement over all three groups tend to be significant. Generally, in pedagogical content knowledge intensified student teachers score better than non-educational student teachers. No significant differences in pedagogical content knowledge regarding to the comparison of first and second measurement over the three groups can be reported. Differences in PCK can be expected at the end of the teacher training because PCK is assumed to be developed by arising teaching experience.4

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THE CYLINDER-AND-CANDLE EXPERIMENT: AN OPEN PROBLEM AND THE LEVEL OF ARGUMENTATION IN A CHEMISTRY TEACHING METHODOLOGY COURSE

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As pointed out by Zeidler1 it is unrealistic expect teachers to adopt argumentation as a practice to teach science without engaging them in the practice of constructive argumentation. In this study we followed five prospective teachers during a chemistry teaching methodology course in which the cylinder-and-candle experiment was carried out. Three steps were applied to foster argumentation: i. presentation of open problem-situation, ii. refinement of problem-situation and iii. reinforcement of the controversy related to data interpretation. Participants' argumentation was videoed and transcribed for analysis. In that way, this study aimed at assessing the student teachers' level of argumentation based on the analytical structure proposed by Erduran, Simon and Osborne2. Figure 1 shows the epistemic operations and the speech turns quantity.

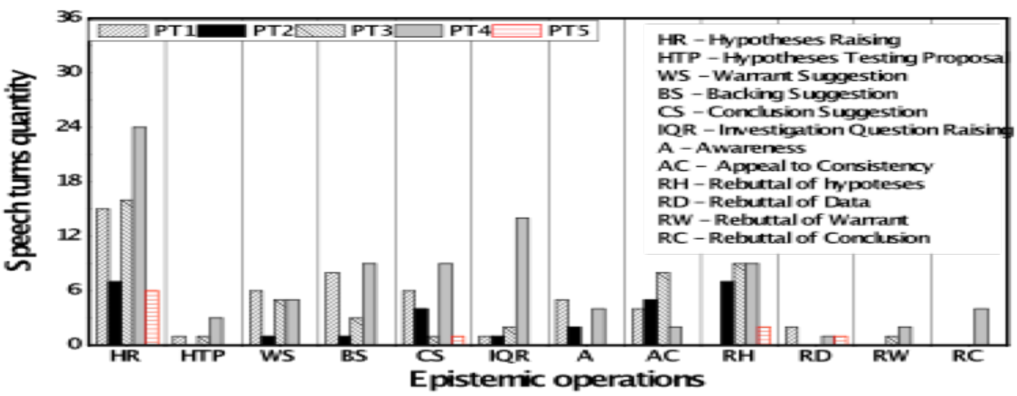

Figure 1: epistemic operations, speech turns and prospective teacher (PT) involved in the argumentation.

The relationship between the number of hypotheses testing proposals and the number of hypotheses raised was 1/13. The speeches analysed showed that when a hypothesis was proposed and questioned or refuted, and if the students believed it, they engaged in discussion which gave rise to a warrant or backing to support that hypothesis or not. This produced a renouncement or refinement of the hypothesis which was tested once a group consensus had been reached. Thus, rebuttals could be identified through extensive argument that contained the elements of Toulmin's pattern. Based upon these data, we consider the prospective teachers produced a level five argumentation, because was identified an argumentation composed by an extended argument with more than one rebuttal2. Also we conclude, based on these data, the candle experiment is a good activity to engage prospective teachers in the practice of argumentation.

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DIRECT AND INDIRECT EFFECTS AMONG PRE-SERVICE CHEMISTRY TEACHERS' ATTITUDE-TOWARDS-CHEMISTRY, CHEMISTRY SELF-EFFICACY, AND CHEMISTRY LEARNING EXPERIENCES AT TERTIARY LEVEL: A STRUCTURAL EQUATION MODELING APPROACH

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The Theory of Planned Behaviour (TPB) is an all-encompassing theory that maintains behaviour is determined by many influences including significant individuals in ones life. According to the TPB, an individual's behaviour is influenced by their attitude toward that particular behaviour, their associates' (e.g., peers, family, and mentors) attitude toward the behaviour, and the individual's perceived control over the behaviour. The purpose of this study was to investigate the direct and indirect effects among pre-service chemistry teachers' chemistry learning experiences at tertiary level on their attitude-towards-chemistry and chemistry self-efficacy via the Structural Equation Modeling (SEM) approach. This was a non-experimental quantitative research and sample survey method was used to collect data. Samples were selected by using a cluster random sampling technique. The Chemistry Attitudes Experiences Questionnaire (CAEQ) (Coll, Dalgety, & Salter, 2002) was adopted to measure pre-service chemistry teachers' attitude-towards chemistry, chemistry self-efficacy, and their chemistry learning experiences at tertiary level. The attitude-towards-chemistry consists of five subscales: Attitude toward chemists, skills of chemists, attitude toward chemistry in society, leisure interest in chemistry, and career interest in chemistry. The chemistry self-efficacy scale consists of one scale with pre-service chemistry teachers not appearing to have different efficacious beliefs for the different tasks in chemistry. The chemistry learning experiences scale consists of four subscales: Lecture learning experiences, tutorial learning experiences, laboratory learning experiences, and demonstrator learning experiences. Pearson product-moment correlation, multiple regression analysis, and Structural Equation Modeling (SEM) were used to test the stated null hypotheses at a predetermined significance level, alpha = .05. This study found that chemistry learning experiences were significant contributors to pre-service chemistry teachers' attitudes towards chemistry and chemistry self-efficacy at tertiary level. The research findings bring some meaningful implications to those who are involved directly or indirectly in the planning and implementation of tertiary chemistry education.

Keywords: *Attitude-towards-chemistry; Chemistry self-efficacy; Chemistry learning experiences; Tertiary chemistry education; Structural Equation Modeling*

IMPACT OF FACILITATED STUDY GROUPS ON STUDENT LEARNING IN 2ND YEAR ORGANIC CHEMISTRY COURSES

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Study groups facilitated by specially trained undergraduate students were piloted in second year organic chemistry courses. Facilitated Study Groups (FSGs) are based on the Supplemental Instruction (SI) model designed to enhance the student experience, reduce attrition, and help students succeed in historically difficult courses.1,2

Among the many strategies used, active learning, which emphasizes the need for learners to engage with material, make mistakes and develop solutions to problems, is fundamental to the teaching philosophy of the FSG facilitators.3

The significant positive effect these peer-run sessions have had on student understanding of the material, in generating enthusiasm and interest in organic chemistry, and the evolution of the program over the different semesters will be analyzed in this presentation. Among students who participated in the study groups (where attendance has been voluntary), we observed a higher percentage of students who obtained an overall A or B as a final grade, as well as a substantially lower rate of attrition. Student surveys conducted at the end of term indicated that a majority of those who participated found the FSGs very useful and enjoyed organic chemistry much more. In addition, the peer-mentor model used in these facilitated study groups has inspired numerous students to want to participate further in the study group program as future facilitators of the same course. Statistical analyses of grade differences, attrition rates and perceptions among attendees and non-attendees of the FSGs over the course of several semesters will be discussed, as well as the variety of activities developed for the study groups. In addition, several other courses in various disciplines have implemented this successful peer-teaching program at the University of Toronto Scarborough through our Center for Teaching and Learning.

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AN EXPERIMENT TO DETERMINE TOTAL ORGANIC CARBON IN WATER FOR TEACHING ENVIRONMENTAL CHEMISTRY TO CHEMISTRY UNDERGRADUATE STUDENTS

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The course of Environmental Chemistry is part of the fifth year of the Chemistry career at undergraduate level at the School of Chemistry. The main objective of the course is developing core knowledge for the students to look for solutions to environmental problems which they will face during their scientific life as chemists. Guatemala is a country with serious problems of contamination of water since there is lack of treatment of domestic wastewater and until recent times the industry has started to treat its wastewater discharges.

Thus, a practical and simple experiment was implemented aimed at the acquisition of laboratory skills and new knowledge regarding the importance of Total Organic Carbon (TOC) and Organic Matter for the environmental quality of water bodies. The experiment consists of the complete analytical process starting from sampling surface sediments in a water body with pollution problems and ending in the results calculation and report writing.

Therefore, the students apply their knowledge acquired previously in the courses of Statistics, Analytical Chemistry and Physical Chemistry, and are stimulated to apply critical thinking to elaborate the discussion of results, regarding the context of the type of water where the environmental samples are collected. Some results will be presented at the Chemistry Congress.

The method is based on the complete oxidation of the organic carbon present in 0.1 to 0.5 g dried sediment to CO_2 by dichromate ion in presence of concentrated sulfuric acid and silver sulfate (equation 1) using a solution of 1.0 N K2Cr2O7 and further quantification of the dichromate excess by Fe^{2+} using a solution of 0.5 N $Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$ (equation 2).

$$3C + Cr_2O_7^{2-} + 16H^+ \rightarrow 3\ CO_2 + 4Cr^{3+} + 8\ H_2O \quad \text{(eq. 1)}$$

$$6\ Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 6\ Fe^{3+} + 2\ Cr^{3+} + 7\ H_2O \quad \text{(eq. 2)}$$

The method has also shown good results for analysing samples of suspended solids with at least 0.1 mg of Non-purgeable Organic Carbon (NPOC), with high repeatibility which it is very instructive for the comprehension of statistical parameters for students, especially considering that the School of Chemistry has not the appropiate instrumentation (non dispersive IR) to analyze TOC by other methods with lower limit of quantification. An alternative method based on ignition of the organic matter did not allow the calculation of the loss of consitution and cristalization water, thus showing less accurate results.

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CHINESE LANDSCAPE PAINTING

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One can illustrate the redox principle in an experiment that combines chemistry and Chinese art. Place a beaker containing purplish-black glistening crystals of potassium permanganate $KMnO_4$ in front of a piece of paper. Pour water glass $Na_2SiO_3 \cdot nH_2O$ into beaker and it will begin to look purple smoke-filled. Then add sodium hydroxide and glucose. The mixture will gradually reduce to dark green manganate (VI) ions MnO_4^{2-}, as if clouds are slowly emerging from green hills. Next add a few drops of hydrogen peroxide H_2O_2, which will restore the brown manganese dioxide MnO_2 and gradually become pink manganese (III) ιονσ Mn^{3+}, and light red, almost colorless manganese (II) ions Mn^{2+}, like the sunset changes the sky. At the same time, due to the decomposition of hydrogen peroxide releasing oxygen O_2 and hydronium ions H_3O, making sodium silicate with acid, a transparent granular material will appear and bubbles will emerge, pushing the particles to the top as if clouds floating in the air. The reaction in the beaker looks like a typical Chinese landscape painting with clouds obscuring mountains.

BIONIC EXPERIMENT: THE GROWTH OF KELP HEXAHYDRATE OF COBALT(II) CHLORIDE $COCL_2 \cdot 6H_2O$ IN THE WATER GLASS IN CASE OF INFILTRATION

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In a transparent beaker, first place the deep purple crystal, hexahydrate of Cobalt(II) chloride $CoCl_2 \cdot 6H_2O$. Then slowly add a diluted aqueous solution of liquid glass Na2SiO3·nH2O. Although any concentration will work, a ratio of 2ml of water to 3ml of sodium silicate works best. Carefully observe the changes in the beaker. Soon, the crystals will start to grow upwards like kelp and a small bubble will develop. As the water continuously formed by the silicate salt semipermeable membrane penetrates the growths, leading to dehydration within the body, the deep purple crystal becomes sky blue anhydrous Cobalt(II) chloride $CoCl_2$ and anionic complex $[CoCl_4]^{2-}$ ions. It is as if the kelp are changing color.

FANTASTIC CRYSTALS

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For five years I grow crystals under different conditions with different methods, watch them under polarized light and make high quality photos and films. The pictures I`ve got, are a link between chemistry and art. From July to September 2010 I had my first exposition of crystal photos in the Cafe Kyburg in Sursee. I showed crystals of citric acid, sucrose, caffeine, ascorbic acid, saccharin and also of a frozen drop of coffee.

Already five graduation works were realized.

The student Nico Röthlin examined the growing conditions of crystals, made lovely photos and cut an amazing film of growing crystals (http://www.mikroskoptechnik.ch/mtd/video/example/kristalle.php). He tested the new microscope system at the Kantonsschule Luzern, Alpenquai.

Severin Koch studied the aminoacids (Glycine, tryptophan, proline and cysteine) and realized also an interesting film.

Damian Höchli dealt with the topics of the visualization of micro-crystals under polarized light at the example of Elmer Citro (mineral water with lemon flavor). He bread crystals of materials which are components in the Elmer Citro.

Marisa Oostenbrug studied the freezing of different water samples as distilled water, grander, seawater and different sonicated water samples. She tested the hypothesis of Emoto, who said that water molecules have a brain, this means that water molecules have a large capacity to store information. A new cooling table was used, which was developed by Mikroskop Technik Diethelm GmbH. This table allowed to cool substances up to minus 25 °C.

In 2011 the students Tobias Kasal and Silvan Steiger studied liquid crystals respectively energy drinks. In 2012 Julia Wüest will examine microcrystals in medicaments.

SOLVING PROBLEMS, PREDICTION OBSERVATION AND EXPERIMENTATION

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In the last years high school teachers have to deal with the same attitude problems inherent to adolesence as usual, but also with an increasing lack of interest on classical classes, maybe in part due to social, economical, and familiar problems, and the amazing time they passed submerged on the net, playing video games, or watching T.V.

I find the need to build a strategy that picks up the interest of the students on Science.

Some students prefer doing almost everything else instead of going in the classroom to work, and some others really want to study and move forward even if they have to solve huge problems.

The question , what can we as teachers do to capture the interested in studying students attention?

Science requires analyzing, abstracting, concentrating and working in an ordered and systematical way. Working in a scientific laboratory could be inspiring but also frustrating. Scientific work requires persistent, analytical and tolerant minds organized in teams. In the school laboratory we work with some bounded problems in teams. Confronting students with an unknown case leads to a number of interesting learning situations. Solving problems in teams can change ideas about science, how science develops, and attitudes to science. Not all the activities are integrated in a solving problem strategy, because the given time is not enough. Some laboratory activities that are presented here, follow the POE model presented by White and Gunstone in 1992. POE helps us to make students think, learn how to contrast a prediction with their results, and push them to analyze. In this work, is presented a solvig-problem, and POE strategy used to approach the ionic and covalent bounds in compounds, starting with the macroscopic observations and going to the nanoscopic explanation.

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INVESTIGATIVE ORGANIC LABORATORY INVOLVING INDIVIDUAL RESEARCH PROJECTS

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A curriculum was designed which involves individual research projects for the nine laboratories of the spring quarter of a three-quarter introductory organic chemistry course. In the third quarter of lab sequence, in carrying out the individual research projects, emphasis is shifted towards obtaining and interpreting data for compounds that are not described in the laboratory manual. The research projects include an on-line literature search, molecular computer modeling, a microscale trisubstituted ethylene synthesis and characterization, scale-up synthesis, and a copolymer synthesis followed by characterization. By changing functional groups on the vinyl monomer molecule, the class can explore reactivity of one "family" of compounds and the corresponding polymers. This approach makes accessible the integration of a genuine research experience with laboratory instruction.

COOPERATIVE LEARNING ACTIVITIES RELATED TO ENVIRONMENTAL CHEMISTRY

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Researches on environmental chemistry have mostly focused on students' environmental attitudes and knowledge. Curriculum development studies for teaching the reasons, effects and solutions of environmental problems are quite limited in primary education (1-3). This situation causes to develop new instructional materials. Therefore, in this study seven cooperative learning activities related to air pollution, acid rain, global warming, ozone layer depletion, water pollution, soil pollution and nuclear pollution were developed for primary school students. The cooperative learning activities based on learning together technique were constructed by considering students' learning difficulties and the learning objectives. In the first cooperative learning activity related to air pollution, a particulate collector is made to teach the sources and effects of air pollution. The second activity is related to acid rain. In this activity, it is aimed students conduct a laboratory activity in their cooperative groups to learn formation of acid rain and the effects of acid rain on environment and organisms. The third activity is related to greenhouse effect and global warming, and in this activity, a laboratory work is designed to have students understand factors that cause greenhouse effect, relationship between greenhouse effect and global warming and the effects of global warming. In the fourth activity named the power of ozone layer, it is aimed students comprehend the reasons and effects of ozone layer depletion. In the fifth activity related to water pollution, students conduct a laboratory work to comprehend the reasons and the effects of water pollution. On the subject of nuclear pollution, two dilemma games are played in cooperative learning groups in order to teach the main sources of nuclear pollution and the effects of nuclear pollution on environment and organisms. The last cooperative learning activity is related to soil pollution and erosion. In this activity, it is aimed students investigate the reasons and effects of soil pollution and erosion. It is believed that, by conducting those activities students will learn environmental issues effectively and their interest, attitudes and awareness about environmental issues will increase.

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STUDIES ON THE SYNTHESIS OF CALIX [4] PYRROLES: AN EXPLORING EXPERIMENT FOR UNDERGRADUATE STUDENTS

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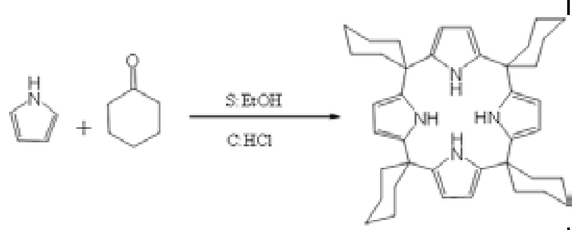
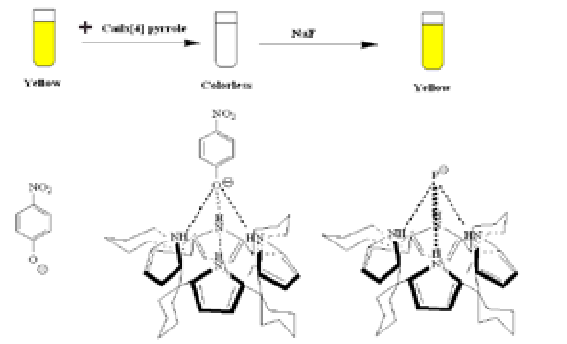
Cailx[4] prrroles, a class of macrocycle compound, have drawn lots of attention in supramolecular chemistry with the excelent abilities in anion recognition[1-4]12. We introduced the synthesis of tetraspiro cyclohexyl cailx[4] pyrrole to undergraduate students, shown in Scheme 1. Ethanol and HCl were used as solvent and as catalysts, respectively, and the reaction conditions were optimized to obtain high yield (higher than 90%). Crystallization from ethyl acetate solution was to obtain the high quality product. At last, we offered a visible method for investigate the anion recognition by the disappearing or reappearing of yellow colours, as shown in Scheme 2. This comprehensive experiment can be used to exam the students' basic skills in organic synthesis, such as the construction of experiment apparatus, the control of the reaction temperature by ice-water bath, vacuum filtration and the recrystillation process. The anion recognition experiment is suited for advanced students.



Scheme1. Synthesis of tetraspiro cyclohexyl cailx[4]



Scheme2. pyrrole Illustration of anion recognition

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EXPLORATION AND PRACTICE OF OPENING INQUIRY-BASED EXPERIMENTS IN UNDERGRADUATE TEACHING

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Traditional teaching experiments usually contain a series of basis operations and classical synthestic experiments. Students only need to implement the experiment by following the operation steps and teachers often instruct them according to the textbooks. This teaching mode is lacking of innovation and exploration, and cannot fully mobilize the subjective initiative of the students. With the increasing support to teaching experiments from the nation, experimental teaching reform is also deepening. Students' comprehending and innovative abilities have become the emphasis of teaching experimental reform. Under this guidance, we have introduced research-oriented experiments in undergraduate teaching and achieved good results through years of exploration and practice [1,2]. Research-oriented experiments require the students to have certain foundation. For this reason, we require students from Department of Chemistry and Polymer major of the Department of Chemical Engineering to participate in this practice after they have finished the courses of organic chemistry theory and basic experiments.

We have implemented this research experiment for 7 years. With the development of new experimental development research, the experimental contents are increasingly expanded; the contents include not only the most fashion projects in current scientific research, but also contents which have been industrialized in production. Through these trainings, Students' ability has been improved a lot. Our research paper Synthesis of an Ionic Liquid and Its Application as Template for the Preparation of Mesoporous Material MCM-41: A Comprehensive Experiment for Undergraduate Students have been published in Journal of Chemical Education.

Keywords: organic chemistry, research-oriented experiment, exploration, practice.

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MULTIPLE DIMENSIONS OF LABOUR IN CHEMISTRY EDUCATION: DEVELOPING AN EXPERIMENTAL LABORATORY FOR PRE AND IN-SERVICE TEACHERS

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The use of different activities associated with everyday life has been studied as an useful tool for improving the scientific literacy, as well as providing a suitable context for establishing significative relations between chemical concepts and social, technological and environmental issues[1.] Unfortunately, chemistry teachers in Brazil have been experiencing a lack of opportunity to develop their skills while using these experiments in their school classes. Besides, most of the public schools in Brazil still don't have laboratories for chemistry experiments, and the classes remain restricted to mainly expositive strategies. This process was once called "banking education" by Paulo Freire2. Since experimental classes are not properly conduced in day-by-day school activities, both pre and in-service teachers in general don't have the opportunity to learn and explore these experiments as a tool for their own future practice. In order to overcome those difficulties we've been working on the development of a kind of multi-dimensional workspace that could help chemistry teachers to develop skills on the use of experimental activities of different patterns. This workspace is called "Laboratory of Didactics of Chemistry" (LaDQuim) and was built at the Institute of Chemistry of the Federal University of Rio the Janeiro. The activities developed in this lab are based on the Science-Technology-Society (STS) approach3 and consider the theoretical concepts developed by Carl Rogers4 and Lev Vigotsky4. As an example of the multi-dimensionality pursued in our activities we present here the structure of a one-week workshop on Environmental Chemistry attended by 17 secondary school teachers of Rio de Janeiro. During this workshop the teachers were accompanied while making activities considering three dimensions, e.g. in, out and trough LaDQuim. All activities were digitally recorded for continuous study and evaluation. Participants were taken to collect water samples from beaches located at the university campus and they also had the opportunity to interview the local workers. After performing chemical and bacteriological analysis, these teachers were able to develop a complex panel of the environmental situation under analysis, relating the results from their investigation with the social and occupational problems they verified in loco.

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CHEMISTRY BUILDING CULTURAL BRIDGES: THE SPANISH CULTURE AS A THEMATIC AXIS FOR SECONDARY CHEMISTRY CLASSES

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Science education in Brazil suffers a direct effect of the social and economic differences among the population, and teaching scientific disciplines such as Chemistry in low incoming boroughs must face the low expectation of social and professional ascendance of the students, as well as the lack of teaching facilities, such as science labs in the schools. Another general problem in this scenario is the lack of cultural background to help students to develop a more accurate criticism. In order to deal with these educational obstacles, a group formed by two teachers from the Federal University of Rio de Janeiro working on Chemistry Education projects and two teachers working on a Brazilian public secondary school developed an educational project designed to promote a more significant learning[1] of chemical topics, as well as to increase the cultural knowledge of second-year secondary students from a school (CIEP Hélio Pellegrino) located in a low incoming area in the suburban region of Rio de Janeiro. Since one of the members of the working group teaches Spanish in the school, we chose the rich Spanish culture as a thematic axis for the project. Thus, three blocks of activities were developed with 25 students throughout the year of 2011. In block 1, the Spanish painting was the conducting theme, and a short talk about Spanish painters was presented by an invited Arts teacher. After this, the Chemistry teacher was able to present inorganic oxides and salts to the students and to discuss the relation between their properties and their role in the composition of inks during the Chemistry classes. The students were also encouraged to prepare their own inks and to use them in their own paintings. In block 2, Spanish gastronomy was presented to the students, and the preparation of the Spanish dish named paella in the school's kitchen was a moment to discuss the chemical composition of food and additives, such as salt and turmeric, as well as to discuss the changes that occur with chemical components of the ingredients, such as the proteins. Finally, in block 3, the students were able to present the results from these activities to the community of the surroundings of the school during a Spanish festival promoted by them in the school's premises. As a conclusion, these activities helped to develop a more significant learning of Chemistry and Spanish culture to this group of students.

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THE CONTEXTUALIZATION OF THE TEACHING ON GENERAL CHEMISTRY IN HIGH SCHOOL

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In this paper we propose as a method of teaching and learning, contextualizing strategy content through problem-based learning (PBL) in the course of chemistry at the secondary school (Morales and Landa, 2004). The content addressed is related to processes of oxide-reduction and being this very complex content in the understanding and interpretation of the concepts that are associated with them (Cárdenas, 2006). With respect to corrosion, oxidation is athermodynamically favorable process in air at room temperature, if not somehow inhibitthe oxidation process can be very destructive, (Askeland and Phule, 2004). As a way to improve student learning, the unit is contextualised through the process of corrosion of metals, which can place them in real contexts. There were two experiences, one is referring to the corrosion reactions that are triggered in a long time because of the constant contact of the coins of $100 Chilean ancient and current with the sweat human, verifying which of two alloys is most affected . The other experience consists of determining qualitatively the degree of corrosion that experience the currencies of the same value mentioned previously, through two media, a dry and a humid ground. Both, coins and reagents are easily accessible. In this study we applied two instruments to obtain the opinions about the effectiveness in the learning process both were applied at the beginning and end. The results were as expected, very good, as students learn to develop scientific skills similar work of a scientist through the contextualization of contents.

Coins immersed in a dry and a humid ground

Coins immersed in artificail sweat disolution pH

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PRACTICAL CHEMISTRY SESSIONS BY MEANS OF AN INQUIRY BASED APPROACH: A CASE STUDY IN THE PHYSICAL CHEMISTRY LAB

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Practical sessions in a chemistry course are meant as independent learning situations in which students acquire and/or practice specific manual techniques, skills or work methods by performing experiments that support the theoretical concepts. Practical sessions where pupils have to follow "recipes" to obtain experimental results that are next being analysed and discussed fit in this view perfectly. Very often a chemistry practical session is hence reduced to an activity where a student strictly follows the teacher's instructions and handles the data according to the procedure described in a text or handbook to obtain a conclusion.

Although this approach is perfect for the development of lab skills such as observing, measuring accurately and precisely, structuring data, etc… it doesn't contribute to the integration of the chemical concepts by the student. Another disadvantage is that students, as they have little or no contribution to the organization of the activity, may find the experiments not challenging enough. As furthermore the experiments that students have to perform are usually not related to situations that are linked with the pupil's environment, this may lead to a decrease of the motivation towards the practical sessions and – more general- towards chemistry.

In the Physical Chemistry Course for 3rd years bachelors in Chemistry at Ghent University, we recently explored a new method for the practical sessions, following a context-rich inquiry based approach. Within this approach, we confronted the students with problems from real-life situations, such as considering the solubility of plaster in different aqueous solutions, the chemical form of ammonia in commercially available solutions, etc.. Students had to look for information, analyze the problem, propose a research method and perform the investigation. They were allowed to use different methods, provided that the necessary equipment was available. Although the students were free to choose the experimental set-up for each experiment, they used the same methods as were used in this practical course before. From interviews it appeared that their involvement for the course was higher than that of students who performed physical chemistry experiments in a non-inquiry based way.

INFLUENCE OF THE SITUATION ON LEARNING: THE PROGRESS OF REACTION

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Teaching and learning of chemistry has long been studied and a large share of the research on this topic has used chemical reactions as a context. Many points of view have been studied like teaching the notion of chemical reaction (Gabel, 1998), and specifically student conceptions (Driver & al., 1985) or their difficulties in understanding this notion (Stavridou & Solomonidou, 2000). But, understanding chemical reaction is difficult because it involves the notion of substance under transformation. A teaching sequence involving an ICT that uses an animation aiming to present a microscopic aspect of the progress of reaction was employed (Le Maréchal & al., 2009). We focused in the teacher activities for structuring student knowledge after this laboratory work. Our research aims to compare knowledge embedded into the student's activity (students are autonomous during laboratory work) and knowledge that the teacher structures when s/he comes back to review student work in the postlab session that we called Debriefing (Khanfour-Armalé & Le Maréchal, 2009). Two teachers and their students were videotaped. The videos were extensively transcribed and analysed from the facet point of view (Minstrell, 1992) where sensitive concepts (when the teacher has a learning objective regarding this concept) were involved. Results led us to characterize the continuity of the knowledge used during a teaching sequence on the basis of the number of facets that the student's activity and the debriefing have in common. Two cases were observed. Both teachers reviewed his/her student's activity using the concepts embedded in the activity. For one of them within the same context as the experimental situations. For the second one it was not the case. New information was added to the definition of the debriefing and the notion of the limit of the debriefing was introduced.

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CHEMISTRY LABS LESS STRESSFUL? LAB SKILLS SEMINARS AND VIDEOS TO THE RESCUE!

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It is well known that the transformation from relatively simple general chemistry labs to much more complicated organic chemistry labs can be very stressful for students. Realizing this we created some tools to make second year undergraduate organic chemistry lab experiences more enjoyable and understandable for students. One of these initiatives was developing videos on main laboratory techniques. We hoped that visualizing the upcoming techniques and equipment would help students to eliminate anxiety of the unknown and allow them to understand lab material better. Several videos have been developed on main laboratory techniques such as simple and fractional distillation, solubility, refractive index, etc. The laboratory techniques web-page is available to second and upper year students through each courses' Blackboard page (Blackboard is our course management system). The other initiative was Lab Skills Seminars which had been created specifically for the large second year Organic chemistry classes. The seminars, conducted over the course of the academic year, intend to better prepare students for the laboratory component of the course by making them comfortable with experimental procedures and apparatus. Surveys conducted about the lab skill seminars and videos as well as statistics of the lab grades indicate students benefit considerably from both – seminars and videos and perform better in the labs as a result.

It is interesting to note that both initiatives would be impossible to do without the help from our Science Engagement students. The Science Engagement program, at University of Toronto Scarborough, is one of the first initiatives which incorporate the idea of service learning on campus. The goal of the Science Engagement program is to deepen students' understanding of their discipline by helping them actively practice concepts and approaches outside of the typical classroom environment. Students working with us are part of the in-reach Science Engagement program. They found their experience working as mentors for Lab Skills Seminars or participating in making video on techniques very valuable. They learned how to interact with the course instructor, peer mentors and course students. This placement allows them improve self-confidence and presentation skills. Seminars also helped in-reach students to solidify their knowledge in Organic Chemistry course and basic laboratory techniques.

Both, Science Engagement and the in-course students benefit hugely from these activities and we will discuss the methods of assessment and the advantages to each group.

THE ROLE OF LABORATORY WORKS IN ANALYTICAL CHEMISTRY FOR REALIZATION OF THE PRINCIPLE OF PRACTICAL ORIENTATION IN TEACHING

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Introduction of the competency approach into the practice of higher chemical-pedagogical education in Russia actualized the use of the didactic principle of a practical orientation in subject training. A considerable role in the chemistry teacher training belongs to analytical chemistry. As a science it is closely connected with many branches of the national economy, other chemical and even humanitarian sciences, and as an academic subject, possesses a powerful integration potential, which is manifested in bringing together its methodology and humanitarian education, strengthening sociality, spirituality, valued emotional aspects of teaching. At the same time it has a strongly pronounced applied aspect, which is reflected in the fundamental contents of the subject. The major component of analytical chemistry presents the ways of activities connected with techniques of carrying out a chemical analysis, mastering of which provides conditions for developing practical characteristics of integrative knowledge oriented to the solution of socially significant problems. In conformity with the new Federal State Educational Standards, teaching analytical chemistry is aimed at the development of such students' professional competences as skills for carrying out chemical experiments, abilities to apply the basic qualitative and quantitative methods of investigating chemical substances and reactions, skills for operating serial equipment, abilities of processing and presenting the results of experiments. Laboratory works in analytical chemistry play the leading part in the solution of this problem through active modes of teaching connected with solving study and test experimental problems, carrying out research works, search for ways of solving regional ecological problems, developing cognitive interest to the material being studied. Sample solutions of some educational experimental problems in analytical chemistry are offered to discuss ways of developing students' practical activities for achievement of predicted study goals.

THE KINETICS OF DOUBLE CLOCK REACTION: A MODIFIED VERSION OF OLD EXPERIMENT FOR GRADUATE EXPERIMENTAL CHEMISTRY LABORATORY

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A well known and interesting experiment named as Iodine Clock Reaction (ICR) has already been used at graduate and under graduate level since last several years, to demonstrate the function of temperature on the rate of reaction (1). Some changes have been suggested to make these excellent dramatic visual reactions more interesting and accessible to the students (2-3). We present here a double clock kinetics experiment based on the repeated oxidation of iodide by BrO_3- followed by H_2O_2. The primarily aim of this work is to enhance the scope of ICR experiment by some modification and extension in the existing experimental conditions. The proposed Iodine Double clock Reaction (IDR) has been successfully employed on the determination of the activation energies of two successive reactions in a single experimental setup. The obtained values of activation energies are 24.07 kJ mol^{-1} and 33.63 kJ mol^{-1} and Arrhenius factors are 2.65 x 10^5 and 1.17 x 10^7 for BrO_3- and H_2O_2 respectively. The obtained data will be helpful to put forward the comparative reaction mechanisms of both the reactions.

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INVESTIGATE MOLECULES WITH LIGHT: STUDENTS MAKE A POLARIMETER

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Secondary school students learn the theory of chirality, a characteristic of molecules, quite easily. On the other hand, it is rather difficult for them to understand the effects and possible practical applications of chirality. We have therefore decided to build a polarimeter with the students. Chemistry and physics teachers of the class collaborate to this project. In fact, to understand how the polarimeter works, the students have to know the characteristics of light, and why chirality could rotate the plane of polarization of light. This aspect needs a multidisciplinary approach.

Another important aspect of this project is the historical view of the importance of resarch in science. So the students will prepare a presentation about the scientists and the historical context that have led to the discovery of the optical rotation. The students also have to check and improve manual and organizational skills and competences in order to make a usable, resistant tool as precise as possible.

We have begun collaborating with the Chemistry Department of the University in Padua in order to make a valid, though inexpensive, tool. We think it is important to teach the students the importance of precision, quality and attention to details. The polarimeter under construction will give us the opportunity to study the rotation of the light in relation to different substances, the path-length of the sample, the concentration of the sample and the wavelength of the light source. The instrument will also be exposed to the 2012 edition of the exhibition "Experiments for Think" that takes place regularly at our high school. During that event, students will also have the opportunity to check their ability to explain to visitors of the exhibition how the instrument works and in writing reports.

The project began in November 2011, and will end with the construction of the polarimeter by next June. We want to test the importance of involving students in practical activities and of working in groups about multidisciplinary arguments. The presentation explains the reasons for the initiative and will present the results of its effect on the students' learning.

MYLAB - A SMALL SCALE CHEMISTRY LABORATORY PROJECT FOR TEACHERS AND LEARNERS

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The MYLAB project began in 1996 and has been running for 16 years. The project was initiated due to the poor results in Physical Science and especially Chemistry in South Africa (TIMSS 1996). Some of the problems identified included under-qualified teachers, lack of facilities and resources, and the prevailing Science curriculum. The MYLAB small scale Chemistry apparatus was developed (accompanied by worksheets: teacher – and learner manuals and DVDs) to specifically address the issues of lack of visualization, resources and qualified Science teachers.

The MYLAB project has spanned three different national curriculums, namley: NATED 550 (A Résumé of Instructional Programmes in Public Schools, Report 550, the National Education curriculum), NCS 2005 (The National Curriculum Statement) and CAPS 2012 (Curriculum and Assessment Policy Statement). Each transition was accompanied with a change in worksheets. The apparatus developed around the worksheets with the 5 ml glass test tube and the base plate and back plate of the MYLAB laboratory as the defining articles. Worksheets were first developed for grades 10 to 12, followed by grades 9 to 4 in Natural Science. Afrikaans translations were done for all 18 manuals. Due to the initially identified issues of under-qualified teachers and lack of resources, no sales were effected without teachers' training and workshops.

The feedback from 55 national and international workshops is unrelentingly positive. External evaluation by the North-West Province Quality Assurance Chief Directorate (October 2006) stated that the project has been successful; the NWU is to be applauded for their foresight in establishing the programme in 2003 and the need of such programmes in South Africa has only increased since then. In future, the project model should be extended to primary and middle school educators. The MYLAB project received a number of awards through the years. MYLAB kits are also used in Norway (Norwegian University of Science and Technology – NTNU, Trondheim) and Ethiopia (Dilla University). Qualitatively there are failures and successes. A number of teachers still do not use the kits even after participating in workshops. However, teachers who are motivated even do experiments with learners in the afternoons if time is limited during regular class time. The next step will be to measure (if possible) the direct impact of the use of MYLAB kits on learners in schools.

- Laboratory Work in Teaching Chemistry (Building active learning environments))

CONCEPT MAPPING AS A VIABLE UNDERGRADUATE LABORATORY LEARNING TOOL IN THE INORGANIC COVALENT CHEMISTRY COURSE

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Background: Student work in the undergraduate laboratory of the Chemistry Faculty is very important; therefore, all the teaching strategies applied in the construction of students' knowledge must be induced when they perform laboratory experiments. Students, with great interest to comprehend how chemical substances change in the reactions and how their properties and structure are modified, will be motivated to answer these questions in each experiment, and by doing so can understand those chemical changes in order to reach an advancement in their knowledge construction.

Methodology: In one semester course of the Inorganic Covalent Laboratory, a teaching technique is induced by asking and answering questions to discuss the previous and new knowledge related to the chemical experiment. First, the students present a discussion about the chemical concepts in the experiment before they are ready to perform them; afterwards, they do the experiment presenting the new concepts they obtained during their laboratory work. Accordingly, they report their results in a Concept Map. Since Concepts Maps are drawings or diagrams that show the mental connections and association patterns a student makes on knowledge learned[1], the more we learn and organize knowledge in a given domain, the easier is to acquire and use new knowledge in that domain. In the first-semester course, about 8 experiments are done as examples: Fremy salt, thiotetrazol, bounce putty, tin iodides, luminescent compounds, in each of them, the students presented the results of their learning in Concept Maps. The teacher uses this material to evaluate students' knowledge construction.

Conclusions: Concept mapping is the technique of externalizing knowledge throught drawings in the form of concept maps. We believe that Concept Mapping is an innovative classroom tool and technique which can deepen our curricula as students advanced through learning chemistry[2].

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ENHANCING LEARNING IN THE LABORATORY WITH BETTER PREPARED TEACHING ASSISTANTS

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Laboratory classes are an essential component of most chemistry courses with the potential to achieve a number of practical and theoretical objectives. Subsequently, the demands on students (and instructors) are great. The students must not only learn manipulative techniques, but also link theory to practice, problem-solve, interpret data, interact with staff and other students, and successfully navigate the laboratory itself. Learning in this situation can be greatly assisted by an educator who is able to guide students through this complex process.

Frequently though, these practical sessions are taught by some of the least experienced members of the teaching staff. Novice instructors usually commence their teaching in first year laboratories where the students are new to the laboratory experience. In these situations, the teaching assistant can have a marked influence (either positive or negative) on the student learning experience. A well prepared teaching assistant can help maximise the learning experience in the laboratory.

In Chemistry at Curtin University, we prepare our teaching assistants by using a three stage process: (i) a full day workshop on teaching in laboratories with a focus on the educational issues, (ii) use of a teaching assistant preparation template to highlight educational objectives and practical issues and (iii) weekly group meetings to discuss teaching strategies for individual experiments. Details of these activities and their impact will be provided in this paper.

TEACHING AND LEARNING STRATEGIES IN THE CHEMISTRY LABORATORY

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Background, framework and purpose

Students should relate their previous knowledge's when carrying out experiments at chemistry laboratory, and involve the new concepts of their work to their knowledge construction in each new experiment they will perform. The single statement that captures the essence of constructivism is that knowledge is constructed in the mind of the learner[1]. Piaget argued that knowledge is constructed as the learner striver to organize his or her experiences in terms of persisting mental structures or schemes, and Bodner2 says anyone who has studied chemistry or tried to teach it others, knows that active students learn more than passive students. Chemist should therefore have a natural affinity for the model which replaces more or less passive recipients of knowledge with an active learner. Methodology: The constructivism model was applied for the fifth-semester students in the chemistry major at the Chemistry Faculty (UNAM) in the Solid State Chemistry lab course with about ten experiments such as Superconductor Construction, Preparation of Colored Glasses, Ceramics, Sodium Analysis in Glasses, Garnets etc. So that about 16 students can become actively involve in their learning. Applying their theoretical knowledge in their experimental work as a previous part of the work in laboratory, they make a conceptual map, present a flow diagram in order to perform the experiment and when finalizing the experimental work, an interactive session takes place in the group to know the results of their significant learning. Conclusions: It was seen by the evaluated results that when applying this active constructivism method to experimental education, students construct their knowledge in a more organized and effective way.

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FORENSIC CHEMISTRY: AN INTERACTIVE LEARNING ENVIRONMENT

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This work deals the planning and the production of an Interactive Learning Environment (ILE) structured as a RPG game and using as themes Forensic Chemistry and Criminal Investigation, and presents a preliminary analysis about how the implementation of this Environment with High School Students can to offer the development of inquiry skills[1,2,] through evaluation of its usability as a didactic resource on informal teaching. The ILE is a learning environment3 inspired in Role Playing Games4, and plans to offer problem-situations and resources (bibliography, experimentals, technologics) to the participants, so that they can, on the moment of interaction with these resources, express their ideias to solve the proposed problem. Forensic Chemistry and Criminalistic investigation were chosen as themes of this project, because they are subjects rarely approached in formal and informal teaching, but with great interest in general public. Specifically, we produced two environments - a fictitious crime scene and an analysis laboratory – and a set of activities that allow the students for search to evidences, collect samples, analyse and evaluate clues and realize experiments. The project involved the implementation of the following methodological steps: to build an Instructional Design oriented by investigative learning using the strategy of Role Playing Game (RPG), and the Criminal Investigation and Forensic Chemistry as themes; to develop the ILE, consisting of two physical scenarios - a "crime scene", containing clues to solve this crime, and a "forensic laboratory", with materials and equipments required for the resolution of the case; to implement the ILE as a university extension activity; and to test and evaluate the ILE developed. Research findings suggested the development of inquiry skills associated with observation, description, interpretation, recognition of scientific concepts, problem solving and communication. In addition, we identified behaviors related to scientific attitudes such as objectivity, parsimony, enthusiasm for research, skepticism, creativity and persuasiveness. On the other hand, have not been identified behaviors related to ambiguity tolerance.

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EXPERIMENTAL STRATEGY IN THE CLASSROOM: WHICH IS WHICH?

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Sand presents a teaching material that brings together 30 aimed at teachers, classroom experiments students promotes learning of conceptual, procedural content, attitude as well as the development of the thinking skills, in accordance with the plans and curricula of our institution.

Our proposal is that the student becomes familiar perceptively with phenomena, to analyze the relationship between variables, to make predictions (hypotheses) and to propose explanations to various phenomena that is show in the classroom, this reinforced by a methodology that promotes greater interaction between the teacher and pupils and among the students themselves.

The proposalis exemplified with the classroom experiment called which is which?, whose objective is for students to establish the identity of four aqueous solutions using various chemical reactions. This demonstration could support the explanation of the topics: importance of the prediction in experimental work, chemical reaction, pH of the aqueous solutions, rules of solubility for inorganic salts and introduction to qualitative analysis.

You should be undertaken at the beginning of the course as motivating, as it represents a challenge for the students, to investigate the previous ideas that have the students about the issues involved or at the end of the course to assess the learning achieved.

This experiment has been tested with the first university semesters students and teachers at high school who have told us that the structure of this material didactic motivates them to improve their practice and they are convinced that with him may reinforce the learning of their students. Congressional activity will be shown to detail.

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A VISUAL DEMONSTRATION OF SOLVENT EFFECT IN CHEMICAL KINETICS THROUGH BLUE BOTTLE EXPERIMENT

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In the study of chemical kinetics usually solvent effect was explained to show the consequences on rate of reaction theoretically which is difficult to understand for under graduate students. The blue bottle experiment can be used to explain well visually the solvent effect through demonstration of color change. Kinetics of reduction of methylene green by sucrose and mannose in pure and aqueous methanol medium in presence of NaOH has been investigated for demonstration of solvent effect. The two sugars sucrose and mannose were selected for the experiment those acts as a reducing agents in a basic solution and reduces the methylene green into colorless form. The progress of this reduction reaction was followed by the color changes that the methylene green goes through

When the bottle is shaken the oxygen in the air mixes with the solution and oxidizes the methylene green back to its intermediate state (purple). The color of the solution will gradually change and become purple (intermediate) and then colorless in 5-10% methanol but in pure methanol color transition were Blue-> purple -> pink indicate the color due to the alcoholic medium. It was observed that increase in percentage in the solvent composition decrease the rate of reaction. The observed variation in reading with solvent compositions has been interpreted in terms of interactions of media with the reacting species and the transitions state involved in this reaction.

Key words: Kinetics, color change, transitions state.

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CULTIVATE STUDENTS' ABILITY OF EXPERIMENTS IN CHEMISTRY BY DEVELOPING SCHOOL-BASED CURRICULUM

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I : the theoretical background

1. The connotation of scientific inquiry

2. Primary inquiry capabilities of chemical experiments

3. The model of science inquiry teaching and research

II: the bases on which the course objective and the content are designed

Design basis:

1. The essential factor of high school students' ability of science inquiry in chemical experiments

2. The teaching model of science inquisition ability

3. The schedule of school-based curriculum

4. The ability of the students with fundamental knowledge who select courses

The design of the course objective and the content

III: the main methods of cultivating students' ability of exploration through the school-based curriculum

1. *create a true experimental situation and encourage students to raise questions and be active in exploration*
2. *Make full arrangements in order for students to make their own blue prints of the experiment, try carrying them out though they may some faults, and correct them Until they find the true ones.*
3. *Offer students enough time for them to discuss and communicate on purpose of improving their cooperative study.*
4. *Make a novel experiment report which is suitable for self-exploration*
5. *Make full understanding of the guidance of teachers to promote students' inquiryability.*

IV: the effect the rethinking of school-based selective curriculum

The effect

1. *Students understand the meaning of the experiment and the basic process*
2. *Students have come to have some idea of raising questions in the view of chemistry during their study of chemistry.*
3. *Students have improved their design and interpretation of the experiments*

The rethinking

1. *Pay further attention to the enrichment and pertinence of the content of the course*
2. *Better summarize overall the practice of the course*
3. *The evaluation of students should be refined and effective.*
4. *The test and the research of students' development and weak points in their exploration should be further stressed.*

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CHEMISTRY TEACHING: LABORATORY PRACTICAL OR COMPUTER SOFTWARE?!!!

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As the world of the computer has developed, there are those who feel that one can learn chemistry by working with software and observing reactions on the computer screen rather than in the laboratory. We totally disagree with this approach. We believe that practical experiments should be the basis of teaching chemistry. Most of the experiments can be performed by the students, or demonstrated by the teacher using simple laboratory set-ups to put lasting impression into the mind of the younger ones. A study of chemistry enables those who study it to acquire certain scientific skills such as handling of laboratory apparatus, performing experiments with ease, and thinking scientifically, with low-cost equipment which is transparent to the user, will improve teaching and learning of chemistry. This paper therefore summaries as follows, that there is really no substitute for hands –on laboratory experience if one is to learn what chemistry is all about.

STRATEGIES TO TEACH CHEMISTRY FOR ENVIRONMENTAL MANAGEMENT BACHELOR´S STUDENTS

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Chemistry is a central discipline for Environmental Management Course students. In order to enhance their academic performance, it was used a context-based approach that improves individuals and group skills, as working with novel problems and planning their solutions; interpretation scientific information and argumentation, as well as communication, information retrieval and time management (Belt et al, 2005, Sá and Queiroz, 2007). As an example, themes such as pharmaceutical products, hazardous waste in water and soil; indoor air quality; recycling of cooking oil and waste were selected to be used at chemistry's disciplines teaching. Every theme was discussed with students as teaching subject, so that they noticed that serious environmental impacts may be caused by ordinary use of products and technology. This work aims to present different ways in which chemistry topics were presented for Environmental Management Bachelor´s Students during 2011 courses as strategies to improve academic interest and performance. To study solutions fundamentals and pH, it was made a group expedition to the Paraiba do Sul River, which runs in the city. They took part in the water global experiment, to celebrate International Year of Chemistry (IYC/2011). At this time, students solving-problems discussing pollution effects over river physicochemical conditions. Oil esterification was used for two purposes. Firstly, to study acid basic reactions. Also, they presented a project for recycling of cooking oil in order to produce soap (FREITAS et al., 2010). This project was designed for small workshops at university. While studying batteries and lithium cells, they proposed collection to avoid disposal in common waste. The group produced panels which contained necessary information about daily attitudes citizen members should take to solve local problems, improving scientific argumentation. Environment context-based and class workshops were effective strategy to maximize the benefits of academic interest and performance of Environmental Management Bachelor´s Students.

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DEVELOPMENT OF EXPERIMENT FOR MEASURING VAPOR PRESSURE USING DECOMPRESSING VESSEL

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Vaporization or boiling is one of the most familiar phenomena of everyday life, but it is one of the most difficult phenomena for student to have scientific concept, because it deals with transition from liquid to gas which cannot be observed by eyes. By prior research, students tend to distinguish between vaporization and boiling by the existence of heating, not by scientific concept as evaporation location or bubble generation. And also vapor pressure is helpful concept to understand the relationship between the boiling point of material and outer pressure, volatile property, enthalpy of vaporization, and intermolecular attraction force. But so far there is not easy and safe experiment for observing boiling phenomena in non-heating situation, and for measuring vapor pressure in various temperatures. In this study, we devised the simple experiment apparatus for measuring vapor pressure using decompressing vessel with pressure gauge and thermometer. Then we measured vapor pressure of water and ethanol in various temperatures, and plotted the graph vapor pressure versus temperature. Data obtained from experiment was similar to reference value. And also we measured vapor pressure of ethanol/water mixture in various ratios. We think that the devised apparatus is useful for teaching the concept related to vapor pressure to secondary school students.

TEACHING CHEMISTRY WITH EXPERIMENTS ON QUALITY OF FUELS AND THEIR ENVIRONMENTAL IMPACT

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Fuels and their relation with energy demand play an important role in our society and should be considered as an important subject for education formation as a critical point of view and discussion. In Brazil, specifically, we have a great diversity of fuels such as gasoline with 20-25 % of ethanol, ethanol itself, diesel and biodiesel used in our cars or trucks. All of this diversity and the complexity of the discussion involving their use, both in a scientific analysis as in socio-economical and environmental view imply in great challenges for teachers, specially because this subject is treated in books in a very restrict way.

This work presents a proposal of using quality of fuels and their environmental impacts in order to contextualize teaching chemistry in a science-technology-society (STS) approach. Three experimental kits on quality of fuels and environmental issues have been proposed and done with secondary students: kit 1- Density of fuels (gasoline, alcohol, diesel and biodiesel), kit 2- Solubility and Determination of Alcohol in Mixtures of Gasoline used in Brazil as fuels and kit 3- Surfactants and Oil Spills Accidents. For each experimental Kit we proposed an STS approach[1] and a previous discussion when the students were able to identify associations with the objectives of the experiments and the properties and socio-economical challenges involving fuels in our society. Thus, we proposed experiments to be done not in a restricted technical way but instead, in a significant learning and critical analysis able to contribute to make students be questioning and more criticizing citizens.

After the experiments, we proposed an evaluating process using different methodologies: written questions and answers, group discussion and oral presentations. The teachers involved played a mediator role orienting the organization of the groups and their discussions, using Vygotsky's point of view.

Kew words: STS, Experiments on Fuels, environmental chemistry

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SELECTED GREEN BROMINATION EXPERIMENTS SUITABLE FOR PRACTICAL ORGANIC CHEMISTRY CURRICULUM

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Research on green bromination method became an essential and integral part of green organic chemistry curriculum. Although recently, green chemistry concepts are being taught all over the world, laboratory course based on green chemistry experiments are very few. All we know that many of the conventional laboratory experiments are involved in use of toxic materials. In the era of sustainable chemistry for environment protection this is highly undesired. So the need of the time is not only to develop but also to practice green chemistry experiments within the chemistry laboratory curriculum replacing the unsafe/hazardous experiments and conventional toxic chemicals as much as possible. Thus, the design of safe green experiments for laboratory curriculum and also to transit the message of green chemistry among the new generation chemists is highly desirable. In India studies on green chemistry also started. Effort on research is more in compare to curriculum development on green chemistry concepts. This paper describes the redesign of suitable green chemistry lab-experiments based on green bromination of organic substrates. Few green bromination methods have been purposefully selected to allow investigation of organic chemistry concepts and techniques in a greener laboratory setting. Green bromination processes are re-designed from standard literature methods to suitably modify and adopt in the organic chemistry laboratory courses. The conceptual themes and experimental techniques of redesigned green bromination experiments can be adopted in lab-curriculum to teach modern practice of organic chemistry in context of environmental impacts of chemical processes. Students will practice with these green techniques and acquire the knowledge to assess the health and environmental impacts of chemical processes which in-turn also encourage them to improve/ develop new green laboratory processes in future. Details of modified Methodologies, green chemistry concepts involved, chemicals/ reagents/materials used, and implication of green lab-experiments based on bromination in the main frame of organic chemistry laboratory curriculum will be presented.

CAN WE SEE (FREE)RADICALS?

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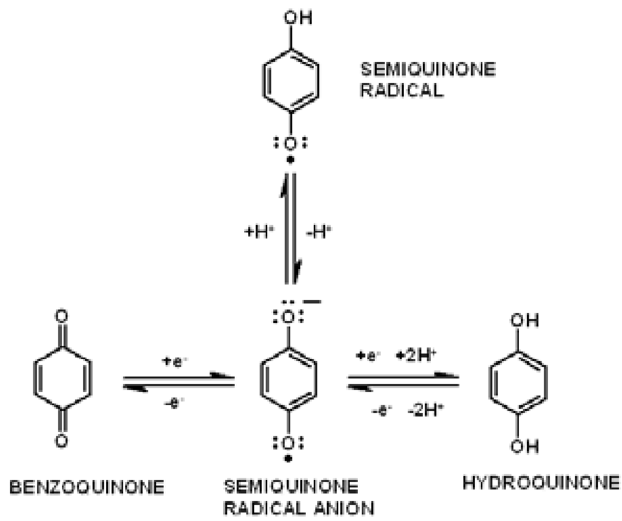
Radicals, chemical species with unpaired electrons, are usually believed to be very unstable; they can be prepared only under special conditions and can be studied only using special, very expansive, instruments. However, due to their unpaired electron, the radicals have a distinct colour, and their appearance can be detected due to a change of colour. Although they are usually regarded as harmful, they have a crucial role in biological reactions.

Semiquinone is an especially important radical, which acts as an electron carrier in the majority of bioenergetic reactions (fermentation, oxidation phosphorilation, photosynthesis). It is formed by reduction of quinones or oxidation of hydroquinones (scheme) in the alkaline solution.



Semiquinone radical anion is easily prepared in the alkaline solution. Due to change of colour, it can be easily observed. Even the reaction mechanism can be deduced only by visual observation: the radical may form either by oxidation of the hydroquinone by oxygen from air or by some other oxidant which is present in the solution. Tetrachlorosemiquinone radical is so stable that it can exist in the solid state: it forms a green potassium salt which can be kept for months.

Several simple reactions, which can be performed in the school laboratory, are described. The substances required are cheap, easily obtainable and not toxic: hydroquinone, benzoquinone, tetrachloroquinone, sodium hydroxide.

APPLIED INQUIRY IN THE EXPERIMENTAL ACTIVITIES ON ANALYTICAL CHEMISTRY IN HIGHER EDUCATION

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The problematization or questioning and laboratory activities are fundamental tasks in the teaching and learning of science, where the most teachers constantly use as a learning tool, although its validity or its effectiveness are not questioned or criticized does not them. The objectives of these activities are only focused on intellectual application skills such as techniques of experimental activity, handling data, formulas and numerical calculations, instruments and materials, clean and orderly work, and strengthen the concepts by the observation of phenomena. This is compounded by the acquisition of cognitive tools, such as inference, generalization, abstraction, hypothesis, and the planning of the research (Del Carmen & cols, 1997).

The instruction that predomines in the experimental activities corresponds to the traditional style in the higher education (also called conference, deductive or "type recipe"). This style is based on manuals or guides to laboratory, to create a situation where the student performs the activity following a prescribed procedure by achieving the predetermined goal. The study suggests to apply the style non-traditional, inductive, or investigative, focusing on the student, he plans and specific research to answer a question in particular, which would enhance cognitive tools that it does have the traditional style (Domin, 2007). Among cognitive strategies of interest in this study, we can mention the critical thinking and resolution of problems.

The study analyzes the perception, development and the improvement of the cognitive abilities of college students through the application of the indagatory methodology in the course of analytical chemistry experimental activities. The study was applied during one semester to biochemistry and industrial chemistry students. The instruments used for data collection were the Test of Critical Thinking, applied at the beginning and end of the semester, and a questionnaire to determine the perception on this methodology and the traditional methodology. The results show an improvement of cognitive strategies evaluated, when are compared with the beginnings results. At the end of the experimental activities, the perception students about the indagatory methodology is better, is more consistent with the experimental work of researchers and/or subsequent labor performance, unlike the traditional experimental activities.

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MICROSCALE ANALYTICAL POTENTIOMETRY: EXPERIMENTAL TEACHING WITH LOCALLY PRODUCED LOW-COST INTRUMENTATION

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MicroISE, microbiosensors and microreference electrodes built with low cost locally produced materials are presented, to perform experiments to determine several analytes in instrumental analysis teaching. Creativity in experimental learning emphasizing ecological and green aspects are achieved. Microscale laboratory has been widely used in General Chemistry mainly in Synthetic chemistry (inorganic and organic chemistry). Analytical Chemistry approaches just concern to titrimetric determinations withy acid.base indicators using 5 mL pipets as burets to teach semi quantitative analysis aspects on teaching laboratories. In our laboratory we have developed low cost equipment with locally materiasl to perform micropotentiometric measurements to teach Instrumental Analytical Chemistry: pH microsensors based on electrogenerated conductive polymers or W° rods, AgCl or Ag2S microcrystal with Ag° transduction to measure cholirde and sulfie anions and also microbiosensors based on fresh vegetable tissue to detect hydrogen peroxide, urea and ascorbic acid in several samples including foods, isotonic Experimental design. Solid state microsensors. The pH determination is achieved with a combined micropotenciometric system: A drawing carbon rod covered with polyaniline, PANI, obtained applying a direct potential 9V pulse. Experimental results. MicropH sensor based on PANI was calibrated with several pH buffer solutions in order to determined the Nikolsky potentiometric behavior. The selectivity of the PANI sensor to H+ in presence o Na+ , as example, was determined by a linear analysis of the type: (10ΔE/60) = f([Na+]/[H+]BS) since the corresponding slope yields the selectivity coefficient kNa,H directly. Results obtained are shown. ConclusionsFrom the results shown it is clear that the microsensors proposed responds properly to several analytes of interest. In all cases the use of reactives are minimized and the generated residues as well. The use of low cost materials minimizes operation and reparation costs. The one- self designing promotes creativity in analytical instrumentation as well.

THE EXPERIMENTS WITH ISOPRENOIDS IN THE CHEMICAL EDUCATION

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Isoprenoids are compounds widely found in nature and can be divided into 2 groups, terpenoids (i.e. menthol, ß-carotene, vitamin A, betuline) and steroids (i.e. cholesterol). They are used in food industry as an additive (ß-carotene as substance to colour products, menthol for cooling effects). Isoprenoids are also used in drugstore (menthol in toothpaste and shampoo, limonen in the beauty care) and medicine (menthol reduce itching, steroids for eczema problems).

Frequent use of these compounds in common life is the reason why we introduce them and their properties (solubility, reactivity, ability to crystallize, polarity) to pupils. The chemical experiments are the best way for this. During these activities the pupils practise basic laboratory techniques - extraction, crystallization, detection, isolation of isoprenoid in the natural materials or from products in supermarket, thin layer chromatography, column chromatography, using UV light, simple organic reaction and other techniques.

We prepared innovated experiments which demonstrate that different isoprenoids have similar properties. Other experiments exploit the similarity of isoprenoids with different types of compounds. In our article we mention experiments with menthol in candies, cholesterol from egg yolk, ester with menthol aroma (ethylbenzoate) and menthyl ester with floral aroma and other experiments.

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AN INTRODUCTION OF MODERN RESEARCH TECHNIQUES TO THE UNDERGRADUATE ANALYTICAL CHEMISTRY LABORATORY: DEVELOPMENT AND IMPLEMENTATION OF A MICROFLUIDICS LABORATORY MODULE

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Over the past two decades, miniaturization of analytical instrumentation has become a dominant trend. The development of microfluidic devices is clearly one of the forerunning themes in analytical chemistry research as indicated by the evolution of dedicated journals, conferences and symposia. While undergraduate students are now being exposed to concepts of microfluidic design and operation in lectures, little has been reported in the chemical education literature to support the notion that undergraduate students are being provided with hands-on exposure to this rapidly developing technology and its applications to research problems that are encountered in analytical chemistry.

The outcomes of work done to develop and implement an advanced undergraduate laboratory module that focuses on microfluidic device fabrication, characterisation and practical application of such devices to better teach the theoretical aspects of microfluidic systems will be presented. The design of the core components of the module will be discussed, namely:

- Practical Skills Development for the Fabrication of Microfluidic Devices: Template Design, Preparation of Castings, Characterisation by Scanning Electron Microscopy and Device Assembly.
- Learning About Fluid Flow in Microchannels: Investigations of Electroosmotic Flow Velocity and Zeta Potential Determination.
- Learning About Mixing in Microchannels: Péclet Number and Diffusion Coefficient Determination.
- Device Construction and Testing: Microchannel Electrophoresis with On-Line Fluorimetric Detection for the Separation and Analysis of a DNA Ladder.

Feedback received from students that have completed these experiments and improvements made based on student input will be included.

PROBLEM-SOLVING ASSIGNMENTS BASED ON LABORATORY EXPERIMENTS IN CHEMISTRY EDUCATION

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One of the priorities in chemistry education is to help students get an overall idea of its primary object, i.e. transforming chemicals in terms of two aspects: qualitative and quantitative. However, in teaching chemistry these are separated as the former is most often presented during laboratory experiments while introducing a new lesson or teaching unit and the latter is dealt with during problem solving tasks while revising and expanding on the previously taught material. Thus, traditionally, laboratory experiments are used in the teaching process without focusing on the calculation part in their organization, while problem-solving assignments are disconnected from their content context.

The author of the present paper suggests that laboratory experiments used for illustrative purposes of a teaching unit and problem-solving assignments based on the quantitative data of the experiments should be combined and dealt with at one and the same chemistry lesson.

The methodology of illustrative experiments involves calculations concerning the amount of chemicals to be used to ensure the realization of demonstrative and instructional purposes, as well as to observe safety rules. These quantitative data may be used in making up calculation tasks concerning the projection of chemical reaction products and practical effectiveness of experiments against prior theoretical assumptions. Such problems made up by students are intellectually stimulating and conducive for the development of their practical skills in using the acquired theoretical knowledge.

The combination of illustrative experiments with problem-solving assignments contributes to a more systemic character of students' knowledge of the subject, their development of practical skills and subject-specific competences. Experiential methods of learning are of special importance in terms of teaching and learning basic competences such as taking measures, performing calculation procedures and using equipment in solving problems.

Besides, classroom work organized along these lines ensures common theoretical background for the activities while its diversified character promotes a more profound understanding of scientific concepts, their insight into quantitative patterns, rationality of calculating procedures and implicit contextual information.

CURRICULUM DESIGN, IMPLEMENTATION AND ASSESSMENT TO SUPPORT LEARNING IN GENERAL CHEMISTRY LABS

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Laboratory instruction is central in the chemical sciences comprising a sizeable portion of students' curriculum, departmental budgets and laboratory space allocation. Reports concerning the effectiveness of laboratory instruction[1] attribute shortcomings not in the practical work itself but in the guiding principles informing curriculum design. These are often based on personal experiences and assumptions2 perpetuating counterproductive lab instructional practices and are not grounded on research literature and outcomes.3,4 Successful implementation ought to extend beyond choosing less traditional instructional approaches and must include careful re-design of the laboratory curriculum, training of teaching assistants, and assessment of learning goals- the latter being a crucial component of curriculum improvement.

This study reports the curricular modifications following the comprehensive assessment of a General Chemistry Laboratory program at a research-intensive US university. This ongoing reform responds to the outcomes of this assessment.2,5 The instructional design was based on principles emerging from research in chemical education and mandates in US National Research Council reports3 and considers (a) Goals and challenges for the chemical sciences reflecting the work of modern researchers in chemistry6; (b) Overarching learning goals highlighted as central in laboratory instruction at the undergraduate level 7,8; (c) The premise that science should be taught as it is practiced. The design approach incorporates technology to support student learning during their preparation and performance in the laboratory sessions. This work employes a bottom-up re-design involving the participants (teaching assistants and students) in first year general chemistry labs. The design task was undertaken by a team comprised by the laboratory course coordinator and graduate students in chemistry some of them in chemical education. The team used a detailed assessment plan to evaluate the outcomes and further guide the iterative development. Details of these outcomes will be outlined in this presentation.

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APPROACH TO TRAINING INNOVATIVE CHEMICAL STUDENTS IN CHINA TODAY

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Since China's reform and opening at the late 1970s, especially, the Project of Quality of Teaching Undergraduate Student in Universities and Teaching Reform and the National Medium and Long Term Educational Reform and Development Plan have been implemented, some new training models of innovative chemical undergraduate students have come forth. In this topic, the new training models, such as chemical fundamental experiment reform, exploiting a lot of chemical comprehensive and designing experiments from research forefront in many China universities, research funding for undergraduate students from department, university, province or/and country, project of training top undergraduate students, etc., are introduced through some cases.

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STUDYING MINERALS

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New experimental laboratory technique focuses on a greater sense of responsibility in regards to the environment, natural resources and personal protection. Actual trends aim to reduce equipment and samples size, thus saving time, space and cost, while reducing effluents and exposure to toxic substances, thus eliminating barriers to student and teacher opportunity for knowledge application and creativity development.

In this work gas releases from various reactions on minerals are identified for study of their chemical properties. Thus, the relationship existing between solid state minerals and gas released is established, for the students to remember aggregate states of matter. Also the importance of continuity and sequence between the units of the program in Chemistry III is highlighted.

Problem

Two types of activities are proposed: a) Experiment development planned by the professor and procedure to follow with a series of questions to answer and b) Search for the solution of a problem indicating only the material and substances to be employed. The program of experimental activities to develop, lead the student to, while carrying them on in the equipment, to observe, form hypotheses and to test them to either accept or reject them. By means of consecutive questions presented to the group and the use of previuosly acquired knowledge, through this work and observations significant learning is achieved. Discussion with team members first and subsequently with the entire group is also part of the assignment.

Results

The experiments presented allow the student to perform them with greater safety by lesser exposure to toxic materials and effluents in a shorter time. The experimental activities promote observation and analysis of phenomena in nature, generating knowledge and understanding from direct contact with chemical processes. Also interaction among students and group discussion are promoted.

Conclusions

Students enjoy the performance of diverse experiments and the observation and sharing skills are enhanced while new knowledge is acquired, all of this in a satisfying and interesting task, improving self satisfaction, significant learning and promoting teamwork.

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DESIGN AND APPLICATION OF FUEL CELL EXPERIMENTAL EQUIPMENT

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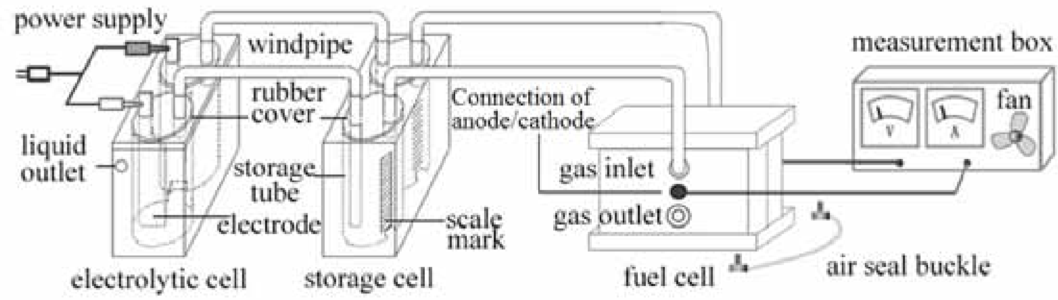
To increase knowledge of senior students in high schools and inspire their interests in fuel cells via practical experiments, a tiny detachable assembled experimental equipment of proton exchange membrane fuel cell has been designed, as shown in the illustration below.



This experimental equipment works as following steps.

1) In the electrolytic cell, potassium hydroxide aqueous solution is electrolyzed and hydrogen and oxygen are produced. 2) Hydrogen and oxygen goes into the storage cell where hydrogen and oxygen will be cleaned and stored separately, and then enters the proton exchange membrane fuel cell. 3) The fan starts to work via power provided by fuel cell. 4) Working voltage and current of the fuel cell can be obtained by the voltmeter and ampere meter in the measurement box, respectively.

The electrolytic cell, storage cell and fuel cell frame are all made of transparent plastic.

The main technical parameters of the experimental equipment are as follows.

Items	*Technical parameters*
Working Voltage of Fuel Cell	*0.3~0.6 V*
Power of Fuel Cell	*15~30 mW*
Frame Dimensions(Length×Width×Height)	*26×10×11 cm^3*

Specific experimental programs have been also designed to help students know more about fuel cells. Significant issues, such as measurement of electrical properties and analysis of working current-voltage curves, have been presented to investigate the effects of hydrogen and oxygen supply on performance and fuel cell efficiency.

INDIGENOUS FRUITS OF INHACA ISLAND AS POTENTIAL SOURCE OF MACRO AND MICRO-NUTRIENTS

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Landolphia petersiana, Garcinia livingstonei, Mimusops caffra, Sclerocarya birrea, Strychnos Spinosa, Syzygium cumini, are some Mozambican indigenous fruits that play an important role in the livelihoods of more disadvantaged rural communities. Traditionally adults eat fruits from the wild while working in the fields and children eat them on their way to and back from schools, or while taking care of family cattle. Although they are consumed by a significant number of the population, they remain underutilized and no studies have been published, so far, on their nutritional composition.

Our research focused on the determination of the proximate composition of some indigenous fruits as a deliberate effort to promote consumption of locally available and easily accessible indigenous fruits in alleviating nutrient deficiencies.

The samples were collected from Inhaca Island, southern Mozambique. The fruits were peeled and the edible pulp removed from the seeds. Proximate analysis carried out included moisture, total ash, crude fiber, protein and minerals [1-2].

From the results, the highest fiber content of 34.48 % was reported in Landolphia petersiana, while Garcinia livingstonei showed the highest ash content of 35.00%. Protein content was observed to be highest in Strychnos Spinosa with a value of 11.48% and Syzygium cumini pulp contained the highest moisture content of 84.95%. All fruits were found to be good sources of micronutrients.

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TEACHER AND STUDENT RELATIONSHIP - MOTIVATION VS. TRADITIONAL EDUCATION

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The analyzes presented in this paper were developed by undergraduate students in chemistry at the Federal University of Uberlândia (UFU), Brazil who participate in the Institutional Scholarship for New Teachers (PIBID – Programa Institucional de Bolsa de Iniciação à Docência) in the Américo René Giannetti State School. The point of departure was to investigate factors that influence the motivation of students in classrooms and teachers' satisfaction with their chosen profession. The survey was conducted with 45 teachers and 112 students. The instruments for data collection were the observation of the relationship between teachers and students built the school, as well as questionings. These required the participants to report the factors of satisfaction and dissatisfaction against the school environment. Students show, through questionings, the teachers' classes are restricted to the content on the blackboard, the own oratory, and a restrictive following to the textbook. According Madeiro1 the student's lack of motivation can be attributed to the school practice traditional focus of content, no meaning for him. Therefore, your cognitive system is not stimulated to understand the information received, thus, a fragmentation occurs when the teacher is restricted to traditional methods, which creates a gap in student motivation. On the other hand, the school teachers' dissatisfaction is due to working conditions, such as social and economic devaluation of the profession, which also directly affect the poor academic performance. The ill-qualified teachers cannot understand the motivation of the student to the class, how he learns, even less, how to help in the process of constructing their knowledge. Often, the reason is restricted to the teacher concerned to comply with the curriculum rather than learning. This is why most educators are still unaware that their actions must be subordinated to teaching students and the situations proposed in the classroom should shed greater cognitive development. Finally, it is concluded that the teaching-learning process to build a mutual relationship between teacher and student, which is interdependent.

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SYSTEMIC OBJECTIVE TEST IN BIOLOGICAL CHEMISTRY

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In the process of teaching, measurement and evaluation are important elements. Nowadays, there are various techniques, instruments, and procedures that help to realize all measurements and evaluations in biochemistry. Testing plays an important place in this system. The objective test is created in a way, that a different estimator that estimates in an independent way, will achieve the same results for the introduced level of knowledge and abilities based on true answers.

In comparison with the traditional objective test, the systemic objective test includes many demands that are completely structured; it covers a huge part of the educational schedule, and measures high levels of education (synthesis, analysis and estimation).

In chemistry, the systemic objective tests (SOT) are prepared and experimented by Prof. A. F. M. Fahmy and Prof .J. J. Lagowski, the founders of the systemic method in teaching and learning chemistry (SATLC).

In this project, I will introduce STFQs, SMCQs, SSQs, SSQs, SAQs, and SCQs as examples of the systemic objective test in biochemistry:

Systemic True / False Questions (STFQs): the student should find the true and false systemic answer.

Systemic Matching Questions (SMCQs): the student has to choose from the concepts and given relations and has to create a systemic diagram.

Systemic Sequence (SSQs): student determines the concept and the relations according to the given sequence in the systemic diagram.

Synthesize Systemic Questions (SSQs): the student determines the relation between the concepts in the systemic diagram.

Analyze Systemic Questions (ASQs): the student analyzes the concepts and their relations in the given diagram.

Complete Systemic (CSQs): the student fills out the concepts or formulas, numbers or events that are missing in the given diagram.

Keywords: SATLC, SOT, STFQs, SMCQs, SSQs, SSQs, SAQs, SCQs.

UPDATE OF THE CURRICULUM OF CHEMISTRY AT THE SCHOOL OF CHEMISTRY IN THE UNIVERSITY OF SAN CARLOS OF GUATEMALA

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The School of Chemistry in the University of San Carlos of Guatemala was founded in 1971 as a part of the Faculty of Chemical and Pharmaceutical Sciences. It oversees the career of Chemistry. The actual mission of the School was stated in a date posterior to the last curriculum update so the objectives of the career are not actually represented in it. The Chemistry students receive 80% of their courses in the first two years with the students of the other four careers of the Faculty (Pharmacy, Biological Chemistry, Nutrition and Biology). Those courses are referred to as the Basic Area, especially in Mathematics, Physics, General Chemistry, Analytical Chemistry, Biology and Social-Humanistic courses.

The last update took place in 2000 and it introduced different elective courses in the career's fifth and final year in order to help the students specialize in the main areas of Chemistry. Since then, the technology has evolved quickly and new approaches for curriculum design have been developed. The current deficiencies in the preparation of new chemists have become evident as the needs of the market, research institutes and the country in general have changed. For example, areas which have developed fast during the first decade of the present century such as Biotechnology, Nanotechnology and Computational Chemistry are not part of the Curriculum.

A participative process to update the curriculum is currently underway. Professors, researchers, students and experienced chemistry graduates have been assigned to update the career profile and to generate a proposal to modify the curriculum's first two years taking into account the importance of keeping a high academic level without neglecting the needs of the students from the other four careers. A two-day workshop was organized as the final activity with participants distributed in different groups. A commission consolidated the final proposal which includes: a) a new career profile with competencies based mission and objectives; b) competencies based programs for the courses of the two first years of the career with emphasis in experiments of the inquiry-based type in General and Analytical Chemistry[1]; c) stronger foundations on Mathematics and Physics to prepare the students for the courses of Physical Chemistry and d) common course of basic Organic Chemistry with the other four careers in the third and fourth semesters which would allow students from other careers to switch to Chemistry if they wish to.

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THE INFLUENCE OF INTERCONNECTEDNESS AND PROBLEM-ORIENTATION ON ACHIEVEMENT IN CONTEXT-BASED LEARNING

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Context-based learning is a widespread and popular learning approach in chemistry education. Important characteristics of context-based learning are problem-orientation[14] and the interconnectedness of everyday life contexts (e.g., fruit juice and teeth) and chemistry-related content[15] (e.g., acids and bases). However, there are few studies investigating achievement effects and their results are inconsistent. Moreover, most studies are faced with methodological problems[16]. Therefore, a more detailed analysis is necessary. This project investigates the influence of the above mentioned features interconnectedness and problem-orientation on student achievement. Each feature is characterized by two parameters: high and low interconnectedness, problem-orientation and no problem-orientation. Learning tasks were developed that vary according to these features. The study employs a pre-post-test design. The dependent variables are situational interest[17] and learning achievement. Learning achievement is measured by multiple choice items on two scales reproduction and application of knowledge. Although the results of the pilot study showed no significant performance differences for the different learning tasks regarding the whole sample, differences could be found in sub-groups. Learning tasks with problem-orientation tended to lead to higher achievement levels for application items. Additionally, problem-oriented learning tasks may lead to a higher learning outcome if they show a high degree of interconnectedness. The tendencies in the achievement might be confirmed in the main study because of a higher sample size and the addition of further learning tasks. The results of the main study will be made available at the meeting.

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CONTEXT CHARACTERISTICS AND THEIR INFLUENCE ON STUDENT INTEREST IN CHEMISTRY EDUCATION

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For about thirty years, real-life contexts have been implemented in several curricula and learning materials all over the world. They are supposed to highlight the relevance and application of scientific content and hence, to raise student interest and learning achievement1. Although a large number of studies could verify these positive effects2, it also became clear that student interest and achievement depend significantly on the chosen context3. For this reason, it is alarming that no category-based and systematic selection of contexts can be found in any approach.

Based on this background, the presented study elaborated characteristics, applicable for the description and categorization of real-life contexts, and operationalized them with the help of paraphrasing statements and adjectives as keywords, combined in a questionnaire. A rating and a student inquiry were used for their validation. In a second project phase, the influence of these characteristics on student interest was analyzed with the help of a second inquiry with students in the ninth grade of upper secondary schools in Germany.

As a first result Figure 1 gives an overview of the central context characteristics. The data analysis of the rating, conducted in order to validate the paraphrasing statements and keywords, has shown an inter-rater agreement of $\kappa = .918$ for the statements and $\kappa = .716$ for the keywords. For the data analysis of the first student inquiry the Rasch-model was used. With the help of the item map contexts with a clear attribution of the according characteristic could be identified and used for the interest analysis in the second student inquiry. As the data collection is still going on, the final results about the influence of context characteristics on student interest will be made available at the ECRICE conference meeting.

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INVESTIGATION OF HYDROGEN PEROXIDE DECOMPOSITION TO IMPROVE THE UNDERSTANDING OF A REACTION OF AQUEOUS SOLUTION

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Introduction

Japanese high-school chemistry text books do not generally describe the solvents used in reactions. Moreover, there is no description of the activity of a chemical species in aqueous solution, some students assume that the same reaction occurs under all conditions. Therefore, it was thought to be important to consider and describe the activity in chemical reactions. It is well known that the rate of a reaction is considerably influenced by the concentration of the electrolyte in aqueous solution. The decomposition reaction of hydrogen peroxide using an Fe(III) ion as a catalyst is considered a good example to help students understand the relationship between activity and chemical reaction in an aqueous solution.

Experimental

A solution containing hydrogen peroxide (0.01 mol dm^{-3}), potassium nitrate (0.01–3.0 mol dm^{-3}), and Fe(III) (0.02 mol dm^{-3}) was maintained at 25 ± 0.1 °C.[1, 2]) The solution was titrated with potassium permanganate solution for a fixed period of time, then the hydrogen peroxide concentration was measured, and the rate of decomposition was calculated.

Result and discussion

Hydrogen peroxide was not decomposed when the nitrate ion was used as the catalyst in aqueous solution, but was decomposed when the chloride and sulfate anions were used. Therefore, chloride and sulfate anions cannot be used as reagents to adjust the ionic strength. Consequently, only nitrate salts were used as a reagent to adjust the ionic strength. The coefficient of the decomposition rate of peroxide decreased with increasing potassium nitrate concentration in the aqueous solution. This phenomenon could demonstrate that the activity coefficient of an Fe(III) ion decreased with increasing ionic strength, according to the Debye–Hückel equation. This decrease could be measured by a redox titration and could be easily demonstrated in an experiment for high-school students. In aqueous solution, it can also be shown that an unlelated chemical species also affects the reaction rate.

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EXTENSION OF ACADEMIC MOBILITY IN NEW SEGMENTS OF EHEA

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At present EHEA is not a purely geographical concept. Extension of Bologna initiatives beyond the EHEA borders is the main indicator of their quality and accordance to modern educational trends. Kazakhstan became the first Central Asian country to implant actively the principles of the Bologna process into the higher education system.

In 2011 Kazakhstan began to implement a large–scale project on the basis of state financing of the exchange programs and exchange education of Kazakhstan students in European HEIs. According to the data of Ministry of Education and Science of the Republic of Kazakhstan more than 300 students spent an academic semester in European countries and this is only the beginning of this financial support of the state.

The programs of academic exchanges primarily required the harmonization of degree programs. Because of the fact that the content of Bachelor's programs in Kazakhstan is still being seriously regulated, the mobility programs are to a larger extent oriented at Master's programs.

The Bachelor's programs, designed for 4 years and 240 ESTS, developed on the basis of competences and learning outcomes, are a very good basis for harmonization of 1-2 years Master's programs.

It is important to take into account that in Kazakhstan there are two profiles of Master's programs: research one and practice – oriented one. The organization of academic exchanges in the majority of cases is realized in research programs, the labor intensity of which is 120 ESTS and is realized during 2 years. At this the learner spends 1 or 2 semesters in the partner –HEI.

The experience of such academic exchanges for the field of chemical education allows to make important conclusions:

1. The level and content of Master's research programs in chemistry, in whole are determined by the level of development of this area of knowledge.

2. There is a considerable disbalance in the research component of the programs. If in European countries the emphasis is made on the research itself, the Kazakhstani programs are focused on the study of methods and means of experimental work.

3. Very high requirements for the research novelty are set to the level of Master's theses. Together with this the applied character of the research still requires discussions and improvement.

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ADDITIVES IN FOOD

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In the last century uncontrolled application of a volume of achievements in chemistry has resulted in a range of problems (environment pollution, foods production…). Solving the problems, apart from chemists, should involve every individual who will take care of what he is taking or giving back to the living environment, who will take care of his health that well-balanced diet is one of the prerequisites for1. Introduction of foodstuffs as teaching content and/or teaching aid in the teaching of chemistry, at different levels of education would provide for perceiving/solving problems of well-balanced diet and developing of chemistry literacy, and vice versa2. Therefore, the examination of the possibilities to present various foodstuffs and additives at the beginning of teaching themes (transition to scientific concepts through spontaneous concepts), at the end of teaching themes (systematizing numerous scientific concepts) and within knowledge testing were performed.

Teaching themes about additives are not present in obligatory chemistry curricula for high schools. Therefore, systematization of knowledge about classes of organic and inorganic compounds was performed through considering the properties that make possible their application as additives. The consequences of eating foods that contain additives in irregular and non-recommendable amounts were considered too. The experiment comprised 90 pupils (age 17-18). Application of laboratory-experimental teaching method during 2 teaching hours made possible for pupils to independently acquire knowledge about additives and their importance in everyday life. All experiments were enquiry-based. By analyzing changes that occured during the experiments all question-form problems were solved. Proposals and investigations were made for classes of organic and inorganic compounds that can be used as additives: acids (metaboric, acetic, tartaric, citric, benzoic acid), salts (sodium hydrogen carbonate, potassium hydrogen sulphate, potassium nitrite, sodium nitrate, sodium benzoate, sodium acetate), oxides (sulphur dioxide) and alcohols (mannitol, sorbitol, xylitol). By applying such teaching methods, it is possible for pupils to acquire new knowledge about the most commonly used additives in foods, about the role of each of them and how they affect the health of each individual.

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THE KINETICS OF DOUBLE CLOCK REACTION: A MODIFIED VERSION OF OLD EXPERIMENT FOR GRADUATE EXPERIMENTAL CHEMISTRY LABORATORY

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A well known and interesting experiment named as Iodine Clock Reaction (ICR) has already been used at graduate and under graduate level since last several years, to demonstrate the function of temperature on the rate of reaction (1). Some changes have been suggested to make these excellent dramatic visual reactions more interesting and accessible to the students (2-3). We present here a double clock kinetics experiment based on the repeated oxidation of iodide by BrO3- followed by H2O2. The primarily aim of this work is to enhance the scope of ICR experiment by some modification and extension in the existing experimental conditions. The proposed Iodine Double clock Reaction (IDR) has been successfully employed on the determination of the activation energies of two successive reactions in a single experimental setup. The obtained values of activation energies are 24.07 kJ mol-1 and 33.63 kJ mol-1 and Arrhenius factors are 2.65 x 105 and 1.17 x 107 for BrO3- and H2O2 respectively. The obtained data will be helpful to put forward the comparative reaction mechanisms of both the reactions.

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ENGAGEMENT AS A PART OF PRE-SERVICES TEACHER TRAINING

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The Learning cycle is one of the most familiar and effective models for science instruction. A model of five phases "5Es" – Engagement, Exploration, Explanation, Expansion, and Evaluation (www.bscs.org) has been developed. During first state 'Engagement' – the teacher sets the stage for learning, wants to create interest and generate curiosity in the topic of study.

Our previous experiences and results of research showed that university students - future teachers have quite large problem with engaging secondary school students during chemistry classes. It is mostly because future teachers (students of chemistry) treat secondary school students as "a younger copy" of themselves , having the some interest in chemistry as they have presented. Future teachers quite rarely take into account a fact that only small percentage of secondary school students will study in the future chemistry at university level.

The 5E Learning Cycle is the preferred instructional model of inquiry teaching and learning for ESTABLISH project. In the framework of that project new activities for pre-service teacher training has been introduced. At Jagiellonian University each group of future teachers draw lots with a question from the book like "Why Don't Penguins, Feet Freeze?" [1-3]. Than they have to do a set of tasks e.g. design a hypotheses, prepare a plan of searching for an answer (literature and/or experiments). Afterwards they prepare a scientific, everyday life context based questions which secondary school students can be curious about – the questions should relate to chemistry core curriculum. Those questions e.g. Why the sky is blue?, Why milk is given during intoxication with heavy metals?, Why baking soda loosens the cake?, Why laundry dries out in freeze despite the fact it does not evaporate?, Why tea changes color after addition of lemon juice, despite the fact the juice is colorless?, Why whipped cream is stiff after whipping?, Why the bottom and sides of a kettle are covered with a deposit? was analysed by a group of students and teachers.

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OPERATIONAL INVARIANTS RELATED TO CHEMICAL REPRESENTATION: DYNAMICS ASPECTS OF THE CONCEPTUALIZATION

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In introductory organic chemistry courses, stereochemistry has been frequently mentioned as a source of difficulties mainly because it requires a clear visualization and mental manipulation of the molecular structures on space[1]. However, been familiar with structural stereoviews is just one of the requisite skills for a proper learning of concepts of organic chemistry. In addition, it is also necessary to understand the conceptual content of the symbolical representations.

This study investigates the processes of formal logical operations of the chemical action of representing and relate them to the conceptual content of thought.

We analyzed data related to stereochemical problems solving gathered from 58 undergraduate students enrolled in Chemistry, Engineering and Pharmacy Courses. The recordings were made on video and transcribed with the help of the software Transana2. In order to access the conceptual elements related to the action of the students, categories were defined based on Vergnaud's Theory of Conceptual Fields3,4, and focused on oral and gestural resources5. The structure of the argument was articulated through the Toulmin´s conceptual content model6.

As a result, three operational invariants were proposed - *the structural identity* (I), *equivalence* (E) and *free movement in space* (M) - as conceptual elements capable of association during the action of the subject. This association represents three schemes, ME, MEI and EI, which account for significant differences in students' proposals and conclusions.

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"ELEMENTS CALENDAR"--AIMING AT ENHANCED PUBLIC APPRECIATION OF ELEMENTS

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Numerous efforts has been paid for enhancing the public appreciation of chemistry as a "central science", part of which are the events for "International Year of Chemistry 2011".[1)] As an idea for potential contribution to such efforts, "Elements Calendar" is proposed, which allocates one element for each day of a year. The number of days in one year is 366, the three times of 122, which happens to be a bit larger than the number of elements authorized by IUPAC, 112 (or 114 in August 2012). Thus, by allocating for each day the 122 elements, incorporating the ten more elements which are not yet authorized or detected (from Uut to Ubb), one can prepare a calendar of an year in which these elements appear in three cycles. In other words, each element appears three times, or every four months, in the calendar in a year. The cycles will be as follows:

January 1 ($_{1}$H) to May 1 ($_{122}$Ubb) (including February 29 as $_{60}$Nd)

May 2 ($_{1}$H) to August 31 ($_{122}$Ubb)

September 1 ($_{1}$H) to December 31 ($_{122}$Ubb)

The prototype of the calendar for 2012 is available on the web.[2)]

With this calendar, one can recognize the "Today's Element" every day, for instance $_{75}$Re for July 15, or one's own "Birthday Element". A few examples of possible applications of this idea in printing and on the web will be presented. With the daily access to this calendar, people would be more familiar to the elements, which would lead to the recognition of the fact that our world consists of as few as ca. 120 elements. In addition, together with the information of the presence and usage of each element, people would also recognize the fact that most of these elements are located around and inside our body and assisting our daily life. This kind of experiences is expected to result in enhanced popularization of chemistry in public.

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"International Year of Chemistry 2011": url = http://www.chemistry2011.org/.

"Elements Calendar (What is today's Element?)": url = http://www.t.soka.ac.jp/chem/e-calendar/.

THE TEACHING-LEARNING OF CHEMISTRY IN HIGH SCHOOL MOROCCAN: OBSTACLES AND AREAS FOR IMPROVEMENT

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Summary:

Our research is at the crossroads of educational research conducted on education systems and lines of improvement. We are interested in teaching and learning of chemistry, one of the most important disciplines that contribute to the scientific training of students.

Our thinking is essentially based on: literature searchs, the findings of our field studies and our experience as a teacher of physics and chemistry.

The obstacles, that we faced, assume almost all components of the teaching-learning system and the different priorities for their improvement revolve around the following vectors: improving curriculum content and textbooks, improving the language used in teaching chemistry, orientation of teaching chemistry to an experimental approach, changing thoughts on chemicals and teacher training and «promotion» of their profession.

And therefore it is critical to build collaboration and coordination of efforts of all partners in the education system and teaching-learning of chemistry in high schools in Morocco.

Keywords: *obstacles, chemistry, teaching-learning.*

CONCEPTIONS OF TEACHERS AND STUDENTS ABOUT THE TEACHING OF THE REDOX

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Summary:

After a search that we conducted with students in secondary school of Morocco about the redox concept, we raised misconceptions among students.

Adapted models and basic knowledge of chemistry are often misused to interpret the chemical transformations and physical transformations distinguish or recognize the phenomena of everyday life that relate to the redox. We have noticed that the basics when they are not well understood is a barrier to understanding the oxidation-reduction model. Nevertheless, it is legitimate to ask whether other factors are involved, such as textbooks, articulation of the different concepts of the program, teaching approaches and selected situations, teachers' conceptions themselves. These designs forged during initial trainingor student who will be mobilized during their acts of teaching, assessment of knowledge, choice situations or program development. Our work aims to raise some teachers' conceptions about the teaching of physical sciences in general and teaching redox in particular and check how much correlation there is between these conceptions and those raised by students.

Keywords: *misconceptions, redox, didactics, model , physical transformation, chemical transformation*

DIFFICULTIES OF STUDENTS FROM THE FACULTY OF SCIENCE TO UNDERSTAND THE CONCEPTS OF CHEMICAL THERMODYNAMICS

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Summary:

The origin of this work on learning of chemical thermodynamics at the university, is the recurrent finding of the difficulty experienced by students resulting in poor marks for evaluation controls. The purpose of this study is to identify difficult concepts in thermodynamics and to identify possible causes of these difficulties and try to offer remediation to these difficulties. For this we developed a questionnaire divided into three categories:

- The general capabilities of the student.
- The teaching conditions.
- Difficulties of students in chemical thermodynamics.

We conducted our survey of chemistry students in Faculty of Science Ben M'sik Casablanca. After analyzing the data we found that the difficulties encountered in chemical thermodynamics may be due to several factors:

- The nature of the concept studied because his understanding is more or less difficult.
- Bases inadequate especially in mathematics.
- The low and middle level students in French language impedes good follow explanations of the teacher.
- The curriculum overload.
- Lack of concentration during the course.
- Lack of motivation of students.

Keywords: *student's difficulties, thermochemistry, teaching-learning.*

THE EFFECT OF COOPERATİVE LEARNİNG STRATEGY SUPPORTED BY POWER POİNT ON SCİENTİFİC ACHİEVEMENT AND DEVELOPİNG ATTİTUDES OF NİNTH GRADE FEMALE STUDENTS İN BİOLOGY

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David and Roger Johnson have been actively contributing to the cooperative learning theory. In 1975, they identified that cooperative learning promoted mutual liking, better communication, high acceptance and support, as well as demonstrated an increase in a variety of thinking strategies among individuals in the group (1). Cooperative learning is an approach to organizing classroom activities into academic and social learning experiences. Students must work in groups to complete tasks collectively (2). The study aims at finding out the effect of cooperative learning strategy supported by power point on scientific achievement of ninth grade female students in Biology in Erbil City, Iraq, through the investigating the results indicated that, there is a significant difference between the mean score of both groups in favor of the experimental; thus the null hypothesis is refused.

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STUDENTS' QUESTIONS: A POTENTIAL RESOURCE FOR CHARACTERIZING STUDENTS' INTEREST IN CHEMISTRY

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The worldwide concern towards declining interest in science among students is emphasized by many researchers. One of the reasons for this decline might be that the science education community has placed more emphasis on 'what students should know about science' but not on 'what students are interested in knowing about science'[1,2.] Exploring students' interest in science in informal settings would inform classroom science teaching and also enhance the attractiveness and relevance of science curricula to students3. Student-generated questions provide insights into the world of the student and give a guide to what the student wants to know4.

Bearing these in mind, this study aims to classify the chemistry questions submitted to a national 'ask a scientist' website with respect to field of interest in chemistry, type of requested information in the question and motivation for asking the question, and to determine whether there are differences in these aspects between females' and males' questions. In order to achieve this aim, 624 self-generated chemistry questions, submitted to the application 'You're Curious About' in the website of Journal of Science and Technology, were analysed based on the coding schemes developed by Baram-Tsabari and Yarden3.

Analysis revealed there were obvious differences in the number of questions asked by females (22.8%) and males (77.2%). However; significant gender differences were not observed in the field of interest in chemistry, type of information requested in the question, and motivation for asking the question in terms of gender. The analysis regarding type of requested information in the question indicated that submitters mostly requested factual information (%46) and explanatory information (%40). Motivation to ask a question was inferred from the question, and was generally not related to direct and/or personal application (8% applicative, 92% non-applicative). For the coding scheme 'Field of interest'; categorization was based on the subject titles of the book written by Ebbing and Gammon5. The results of this coding scheme showed that the most interesting category was 'Atomic and Molecular Structure' (25%). The findings of the study might be of interest to a myriad of science educators since the results of the study shed light on what students are interested in knowing about chemistry.

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THE USE OF MEDICINE: FOURTH GRADERS' PERCEPTIONS

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Using medicines is a common activity for almost everybody and many people have negative expectations or even fear in relation to their use (Menacker et al. 1999, Hämeen-Anttila et al. 2008). However, medicine education is not about scaring children, urging them to use more medicines, or using them independently, it is about learning an everyday life skill before becoming personally responsible for one's own health. It is a part of school chemistry, biology and health education. This study aims to clarify fourth graders' (N=51, age 10) perceptions about the use of medicines. The data has been collected using a questionnaire constructed together with pharmacists, teacher educators and teachers and is based on the principles of medicine education (Hämeen-Anttila 2006). Pupils were also asked to draw a medicine cabinet.

Pupils most frequently perceived that the purpose of medicines is to treat a headache, listing several over-the-counter (OTC) medicines (i.e., medicines bought from a pharmacy without a doctor's prescription), also that they could be used in the case of wounds or temporarily when they are sick or have some pain. Chronic diseases were pointed out only in a few cases. Pupils got information about medicines from the pharmacist, the Internet, the physician as well as from medical package; medicines help to ease symptoms and speed recovery. About half of the pupils perceived that with some limitations children can take the same medicines as adults, also that children over 11 may, without parents' supervision, take medicines for minor illnesses. If the medicine does not help, pupils perceived that one should go to the physician. A typical medicine cabinet included OTC-medicines such as painkillers, medicines for coughs and colds as well as first aid equipment. Pupils mainly drew medical packages which included the label of the product.

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DECLINING ENROLLMENT IN CHEMISTRY – AN ALARM NOT TO BE MISSED

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Chemistry being a multidisciplinary science, higher education in chemistry plays a crucial role in the economic and industrial growth of every country. In India, the current status of chemistry education is under tremendous pressure in terms of attracting and retaining talented students to pursue education in chemistry at the undergraduate level.

This paper deals with the problem of declining enrolment in the third level education of chemistry in Indian Universities, and more specifically, the University of Mumbai, a portal of 150 years of sustained reputation. It analyzes the data of students who opt out of chemistry after the first or second year of enrollment into the three year undergraduate program. Furthermore, this paper attempts to suggest a few feasible and viable solutions to cope with this setback.

INTERLABORATORY STUDIES OF WATER IN SOUTH–EASTERN EUROPE: COMBINATION OF JOINT RESEARCH AND LIFE LONG LEARNING

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Interlaboratory studies are important for the improvement of the quality of chemical analyses, accreditation of laboratories and the introduction of quality system based on the ISO 9000 standards in chemical laboratories. In order to improve the quality of chemical analyses of water in South-Eastern Europe the long term project was initiated and seven interlaboratory studies were organised in the period 2003-2011. The International Scientific Committee with professor dr. Anastasios Voulgaropoulos as the Chairperson organised and evaluated regional interlaboratory studies. More than 70 laboratories from Greece, Montenegro, Republic of Srpska - Bosnia and Herzegovina, Romania and Serbia took part in them. The samples for regional interlaboratory studies were prepared from filtered water of the river Danube near Belgrade by addition of corresponding substances. In each regional interlaboratory studies one of the the task for participants was to determine trace elements (Al, As, Cd, Cu, Mn, Fe, Pb and Zn) in two water samples. Results were analysed using the same methods as in interlaboratory studies organised by IRMM-JRC (Institute for Reference Materials and Measurements: EU-Joint Research Centre, Geel, Belgium) within IMEP 1,2 (International Measurements Evaluation Programme). All regional interlaboratory studies were generally successful and useful for participants. There was a good agreement between results of most laboratories. Systematic errors were observed in some cases and these laboratories need to improve their performance. The achievements were better than in some earlier interlaboratory studies 3 as the quality of results for some elements improved gradually in the period 2003-2011. Whenever possible the meetings with participants of interlaboratory studies were used for some lectures on new analytical methods or demonstration of laboratory instruments as well as for distribution of information/relevant literature (new books, papers, internet sites). The meetings also enabled professional discussions on analytical methods, instruments, equipment, etc. and better co-operation in the future. Similar regional interlaboratory studies will be organised in the future.

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TEACHING RESEARCH AND APPLICATION ON THE EFFECT OF A NEW TEACHING METHOD IN HIGH SCHOOL CHEMISTRY CLASSES - "S TUDY, AHEAD OF TEACH, BE TAUGHT IN SCHOOL"

Ge-Bing Ding, Chi Li, Chun-Hua Liu

A new teaching model was d escribed as a "student-centered and teacher leading" method in high school chemistry classes. This model was explained as " study, ahead of teach, and teaching according to the students' needs". In this model, the teachers and students should finish at least two times of "learning and teaching" in order to understand the importance of learning resources. In this procedure, the teaching in class had been designed, and the students experienced at least 2 times "learning". The first "learning" is performed by themselves, the second by teachers. This article also described the role of the teacher and student in this new teaching model, the requirements of implementation (including the study design and classroom teaching process), and evaluation methods.

Keywords: The new teaching on new teaching in high school chemistry, teaching according to student's needs, teaching model, design of study case, e ffective teaching, student-centered education.

SCIENCE-GIFTED MIDDLE SCHOOL STUDENTS' MODELING AND SOCIAL CO-CONSTRUCTION TYPES : THE LESSON WITH THE UNIT OF MATTER CHANGE

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The purpose of this study was to analyse the science-gifted middle school students' modeling process and social co-construction types during their cooperative learning of modeling inquiry. The modeling inquiry learning modified and supplemented the Model Learning Cycle of Holloun, and was developed for the six lessons, The developed material was implemented to 19 middle school of the first-grade at the Education Center for Gifted Children. Data was collected through participated observations, documents, and survey. The result of research showed that the model which made by student reflected the student's reasoning system for science concept.

The ways of the group's choosing and modifying the scientific model differed by the social co-construction types of the group members. Moreover, the model inquiry learning has a positive effect on learning of the natural phenomenon and science concept. Analysis of models suggested by students is expected to allow for the understanding of student's reasoning system about the natural phenomenon, which will in turn contribute valuable information to deciding the direction of scientific study.

THE EFFECT OF USING COOPERATIVE LEARNING ON STUDENTS` ACHIEVEMENT IN ORGANIC CHEMISTRY: (WITH SPECIAL REFERENCE TO HARAMAYA UNIVERSITY FIRST YEAR CHEMISTRY DEPARTMENT STUDENTS)

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The purpose of this research was to investigate the effect of cooperative learning on achievements of first year chemistry students' learning outcomes in organic chemistry in Haramaya University. In this study, 14 females and 91 males (totally 105) students were participated. Since, the nature of this research is experimental; the sample students were randomly divided into experimental (51 students) and control (54 students) groups based on their section. To suit to the purpose, the subjects in both the treatment and control groups were exposed to the same study unit that actually covered during organic chemistry I. For the former group the contents of the unit were treated with an approach (cooperative learning), while for the later, the same was dealt with following the traditional lecture method approach. To measure differences between experimental and control group, identical pre-test, quiz, assignment, and post-test evaluations were administered simultaneously. The results obtained indicated that, there was no significant difference in the pre-test and assignment achievement scores of students between the experimental and control groups, whereas, statistically significant difference was observed between experimental and control groups with the two sample t-tests (at $p<0.05$) taken on the quiz and post-test achievement scores of students. The experimental group students were found to be more benefited than those in the control group. The responses to the questionnaires gathered from the experimental group have indicated that cooperative learning was effective in acquiring Chemistry concepts during working together with in their group. This is also supported by experimental group students' positive attitude observed on some interviews made regarding the effectiveness of cooperative learning experiences in organic chemistry class.

Key words: cooperative learning, lecture method, experimental group, control group

RESEARCH ABOUT THE ACADEMIC COMMUNITY AND PUBLIC SCHOOLS AWARENESS OF UBERLÂNDIA ON THE APPROPRIATE DISCARD OF THE USED CELL PHONE BATTERIES

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This paper focused on the mapping of the behavior of the academic community of the Federal University of Uberlândia/UFU and two public schools in Uberlândia, in partnership with the Institutional Scholarship for New Teacher (PIBID- Programa Institucional de Iniciação à Docência) - chemical sub-project program. Initially the project containing an environmental questionnaire partner was submitted to the Ethics Committee of the Uberlandia University to securing the integrity of research subjects. The Bueno Brandão and Américo Renê Giannetti state schools were selected in partnership with the PIBID-chemical sub-project Program. In these schools, theoretical and practical mini courses were conducted witth 65 questionnaires were applied in the Public School of Uberlândia and 169 questionnaires in the academic community of UFU. It was observed in the treatment of the data obtained by questionnaires that the most of the volunteers in the study of both the Public School, the academic population of UFU noted the appropriate locations for the collection and disposal of used batteries only after the application of these questionnaires. Therefore, the most of the respondents drops used cell phone batteries in their own household waste generated and they do not know the locations which have suitable collectors. Besides, they say to be aware of your responsibility but, they consider the manufacturers of batteries and electronic devices like the real responsible. As a result, the majority of the respondents always ends up keeping the batteries or dropping them in the inappropriate places that promote a major environmental impact in the future. Based on the data obtained it was observed that the respondents do not know the locations which have suitable collectors of used cell phone batteries and thus they consider the manufacturers of batteries and electronic devices like the real culprits. The paper goes on the prognosis of raising awareness of the academic community and of the Public School of Uberlândia.[9]

STUDENTS CONSTRUCT AND EDIT VIRTUAL MOLECULES THANKS TO A PHYSICALLY-BASED MODEL

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Wooden ball-and-stick models are extensively used to materialise molecular geometries in labs and schools throughout the world. Unfortunately, these geometrical models poorly represent key chemical phenomena, including bond formation and dissociation, deformations or configurational changes under constraint, and vibrations, all aspects that are very important to describe and understand molecule properties. Carbon nanotubes, for example, are 1D nano- objects that can be reversibly folded with considerable deformations of atomic bonds (which questions the macroscopic distinction between elastic and plastic deformation). Another central property is molecule vibration. Thermal vibration is the reality of heat at nanoscale. All these aspects are included into a new interactive software based on the real-time calculation of the Brenner potential [1], a reactive bond-order potential that realistically represents inter-atomic forces in hydrocarbon systems. This software has been developed at the NANO-D group at INRIA, following a request by chemists and physicists [2]. It can calculate in real time the potential energy of a molecule, and relax it to the closest energy minimum (minimisation mode). Students can assemble atoms at will, form and break bonds, and deform the represented molecules using mouse and keyboard. Variations of configuration energy, applied forces and resulting bond length deformations may be displayed in real time. A dynamical mode can also be activated. It shows how atomic vibrations of molecules depend on stored deformation energies. Modules include molecules such as CH4, C2H6, C6H12, C60 and carbon nanotubes. Pedagogical scenarios have been proposed to 17-year-old students to investigate molecule constructions, conformations, deformations and vibrations [3].

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CONTRIBUTIONS OF THE PIBID PROJECT ACTIVITIES TO THE QUALIFICATION OF UNDERGRADUATE STUDENTS IN THE CHEMISTRY TEACHING COURSE IN A BRAZILIAN UNIVERSITY

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The Institutional Program of Teaching Initiation Scholarship – known as PIBID in Brazil, promoted by CAPES (Coordination of Higher Education Personnel Qualification) aims to value teacher training for basic education and to improve the quality of the Brazilian public education. The program intends to promote the insertion of future teachers in the everyday school practice through the development of activities that contribute to their didactic and pedagogic training, and favor high school students learning[1.]

The PIBID/Chemistry group in UNICENTRO is composed by 20 undergraduate students in the Chemistry course, four supervisor teachers from four public schools and an area coordinator.

The activities developed involve the knowledge of administrative and pedagogic dynamics in schools, physical structure assessment, development of teaching activities in the classroom under the supervision of the teacher in charge of the subject, creation of teaching material, and research into teaching. These activities seek to overcome the dichotomy theory-practice related to the teacher practice which is still present in the teaching courses in Brazil2 .

Experiencing everyday teaching in schools helped the future teachers to develop professional ethics and critical sense as well as to leave behind certain simplistic views about teaching3.

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PRELIMINARY ASSESSMENT OF DRINKING WATER QUALITY (UNDERGROUND AND SURFACE WATER) IN THE VICINITIES OF KHAIRPUR, SUKKUR, ROHRI, SHIKARPUR AND GHOTKI CITIES OF UPPER SINDH, PAKISTAN

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The surface and subsoil water of four district headquarter cities Khairpur, Sukkur, Rohri (twin cities) Shikarpur & Ghotki of upper Sindh were monitored for different water quality parameters with main focus on detection of arsenic to make masses aware of the drinking water quality to ensure the safe drinking water (within the recommended levels of WHO) used by the urban population for this purpose 110 samples Khairpur 35 Sukkur & Rohri 30, Ghotki 20, Shaikarpur 25 were collected from different localities of the cities and their outskirt. This practice was repeated thrice. The samples were analyzed in department of chemistry SALU Khairpur for pH, conductivity, chloride content, major elements (Na, K, Ca, and Mg) and other metal contents Fe, Cu, Ni, Pb, Cd, Zn, Mn, Co and also with special emphasis on hazardous element arsenic. The major metals were determined by FAAS (Flame Atomic Absorption Spectrophotometer) while arsenic by FAAS coupled with arsenic hydride generator.

The analytical investigation of drinking water of study area revealed that the water of Khairpur district was alkaline in nature with pH in the range of 7.86-9.24 and high level of TDS reaching up to 220-1850 ml/L, while chloride contents were within the limits of 37-2993mg/L. The upper limit of chloride was 12-fold higher than WHO permissible limits. The presence of arsenic at few locations was the 16-65 µg/l (the recommended values of WHO) is matter of great concern and environmental disaster.

In district Ghotki, the pH was alkaline (7.98-8.95) while chlorides and TDS were within permissible limits of WHO, while arsenic concentration was detected in two samples 60 µg/l and 95 µg/l above the recommended levels of WHO.

The water quality parameters including TDS, Chlorides were well within the permissible limits of WHO in District Shikarpur. The arsenic in almost all the samples Shikarpur district was not detected.

The water of Sukkur & Rohri city was highly polluted with significant concentration of arsenic. In most of the samples analyzed, about 30% samples from district location had high levels of (55-180 µg/l) Arsenic well above the WHO recommendations.

The sequence of major metal ions with reference to the concentration was Mg>Na>Ca>k in Shaikarpur, Sukkur, Ghotki, but in Khairpur slightly changed pattern Na>Mg>Ca>K was observed.

The overall variation in the level of ion Cu, Ni, Mn, Pb, Cd, Co, Zn was 8-240 µg/l (mean)except iron whose concentration was within the range 830-128 µg/l.

Key words: *Khairpur, Sukkur, Rohri, Shikarpur, Ghotki, drinking water, Flame Atomic Absorption Spectrophotometer.*

DEVELOPMENT OF COGNITIVE ACTIVITY OF STUDENTS IN TEACHING CHEMISTRY

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In the information society, the goal of education is the formation of preparedness of graduates for self-development and self-education throughout life. In other words, teachers should to develop cognitive activity of students.

There are different viewpoints on concept of "cognitive activity". In our view, cognitive activity is mental state, property of the person, which is characterized by a desire for learning with mental and strong-willed efforts.

A lot of researches on the development of cognitive activity in learning chemistry have been published. However unsolved problems remain. For example, cognitive activity in learning chemistry was researched in isolation from development of wills.

Our concept is based on the theory of self-actualization A.Maslow, on the ideas of humanistic psychology C.Rogers, on three tiered structure of cognitive activity T.Shamova, on technology of personality-based learning.

For the development of reproductive-imitative activity of students (1-st level) teachers should activate such motives of students, as "interest" and "useful". Educational games, game situations in the classroom, fragments of literature, poetry, painting, film, and historical data should to increase emotional component of learning. We have developed criteria for the selection of optimal methods for group training. Observation for students' behavior, permit to optimize the content, methods, forms, means of their learning activities.

For the development of executive-search activity (2-nd level) we have developed criteria for choosing the optimal teaching methods depending on the individual student's cognitive characteristics. The success of cognitive activity, the joy of problem solving determines the desire of students to study/

The level of creative activity (3-d level) involves a conscious attitude of students to self-regulation process of cognitive activity. Reflection of cogitative strategies and mutual exchange of thinking styles is a prerequisite for the development of students' ability to solve creative problems with using of new original method.

Our study showed that the development of the student's cognitive activity in learning chemistry is a complex multidimensional problem requiring the realization of personality-oriented teaching methods. Development of cognitive activity of some students may be nonlinear.

THE "CHEMISTRY IS ALL AROUND NETWORK" PROJECT

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The "Chemistry is All Around Network" is a three years project funded in the framework of the Lifelong Learning Programme – Comenius sub programme – Networks Action, aiming at stimulating the interest of students towards the study of Chemistry.

The identified background of the project idea relies on the evidence of common needs within the eleven countries involved and in Europe in general, related to the insufficient diffusion of scientific culture and awareness, that starting from the school level (primary and secondary education) affects all levels of educational and training systems and therefore citizens in general.

Among the scientific fields, Chemistry is identified as an exemplary Case Study as it is recognised as one of the most difficult subjects, as evidenced by the results of the former project "Chemistry Is All Around Us"[1], ended in march 2011, dedicated to enhance the lifelong learning of scientific subjects in Europe.

The specific aims of the Chemistry is All Around Network are:

- Enhance the interest for chemistry, by sharing the most effective strategies for learning and teaching this subject.

- Present chemistry under a renewed and positive attitude, by giving evidence to how it affects everyday life and how it can contribute to the explanation of many everyday phenomena.

- Improve science teaching methodologies through the cooperation between teachers and experts.

- Create a Network among educational institutions for the exchange and comparison of experiences in order to fill in the gap between the world of scientists and school teachers.

The project involves thirteen partners from eleven different countries, sharing experiences and information in the common effort of promoting the learning of chemistry. It is based on the collaboration of school teachers, scientific experts and university researchers and foresees different activities in order to fulfill the above aims. Research activities, collection of teaching resources, organization of national and transnational meetings, organization of international conferences will be carried out according with the three area of interest of the project: 1. student's motivation; 2. teacher's training; 3. successful experiences and good practices.

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A STUDY OF THE INFLUENCE OF RCPS INSTRUCTIONAL DESIGN ON STUDENTS'

SCIENTIFIC LEARNING MOTIVATION AND SCIENTIFIC CONCEPT LEARNING

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This study tried to develop revised creative problem solving (abbrev. RCPS) instructional units in junior high school chemistry course. We explored the influence of RCPS on the students' scientific learning motivation and scientific concept learning. The treatment used for this study was quasi-experimental nonequivalent-control group design. Subjects include 28 eighth graders for experimental group and 28 eighth graders for control group from junior high school. The instruments include Scientific Learning Motivation Inventory and Scientific Concept Learning Test. The major findings were that RCPS instruction can increase students' scientific learning motivation and improve scientific concept learning. Based on the findings of this study, we proposed the RCPS model and suggestions for junior high school chemical education and future research.

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USE OF THE LABEL OF BOTTLED MINERAL WATERS: A WAY TO INTRODUCE THE PROPERTIES OF ELECTROLYTIC SOLUTIONS

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In this communication we show how to use the chemical and physico-chemical data reported on the label of the bottled mineral waters to introduce the chemistry of acqueous solutions to General Chemistry classes.

We ask our student to check the electroneutrality of the solutions starting from the qualitative and quantitative analysis of the ions. After this exercise it is possible to form a hypothesis about the presence of silica in mineral water solutions: is it present in the neutral colloidal form (SiO2) or as an anionic species (H_3SiO_{4-}, $H_2SiO_4^{2-}$) ? The second hypothesis cannot be true because it implies some deviation from the electroneutrality condition. The pH of the solutions may also be calculated from the concentrations of dissolved carbon dioxide and hydrogencarbonate anion. The colligative properties (osmotic pressure and reduction of the freezing point), which are often reported, can be calculated and compared to the experimental values.

We also devote a special attention in introducing the electrical conductance of electrolytic solutions because this subject permits to demonstrate in a direct manner the effect of electrostatic interactions in concentrated solutions. The specific conductance of the mineral waters may be calculated from the sum of the molar conductance of each ionic species at infinite diluition wheighted for the corresponding concentration. The so obtained values are compared to the experimental ones showing deviations from linearity which increase at increasing ionic force of the solutions which is a fundamental concept that the students will use soon, both in theory and in practice, in the advanced Analytical and Physical Chemistry courses.

KOREAN SCIENCE TEACHERS' PEDAGOGICAL CONTENT KNOWLEDGE REPRESENTED IN TEACHING PRACTICE AT MIDDLE SCHOOL CLASSROOM

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The purpose of this study was to investigate middle school science teachers' Pedagogical Content Knowledge represented in instruction and by other influential factors. For this study, 3 teachers were chosen as subjects. The data of this study were collected through qualitative research methods, such as semi-structured interviews, classroom observations and CoRe questionnaires. Data were analyzed by using a constant comparative method after transcription. The three teachers› PCK that were represented in science classes were affected by the teachers› own practical experiences, textbooks, and learning materials. But their PCK was not affected by their university studies and their teacher training program. From these results, it was concluded that understanding learners was a very important component in developing teachers› PCK. The teaching experiences were main factors in understanding their learners. Therefore, it is suggested that teacher education programs for pre-service and in-service teachers need to design programs that develop teachers› PCK. Teachers› PCK varied in their assumptions on whether students were active learners in class or not. From the moment that the teacher assumed the students to be passive learners, it was difficult to develop the teachers› PCK as being inquiry-driven. So it was ultimately important to understanding both the learners and teachers› experiences. Also, reflective thinking of subject-content based on the nature of science was important in the formation of the teachers› PCK. Ultimately, internal factors affected the teachers› PCK more than the external factors.

As a result, we suggest that further research on the following topics: first, the teacher training program should include reflective thinking of subject-content through teachers' own practical experience. Second, the teachers suffered difficulties from developing their own PCK individually. Therefore, we suggest that a supporting system should be in place for the teachers to share knowledge with peer groups and educational specialists. Third, PCK was the knowledge that was obtained through teaching practice linked with teacher›s beliefs. Also, beliefs didn›t change quickly. Therefore, it is necessary for programs to be in place to support and help in developing teachers› PCK continuously. In addition, the teachers in this study wanted to know more insights of teaching methods related to teaching subject-content. Therefore, practical strategies related to specific topics are needed to develop advanced teachers› PCK.

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