

# THE 4<sup>th</sup> INTERNATIONAL CONFERENCE RESEARCH IN DIDACTICS OF THE SCIENCES

## BOOK OF ABSTRACTS



**KAPITAŁ LUDZKI**  
NARODOWA STRATEGIA SPÓJNOŚCI

**UNIA EUROPEJSKA**  
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PEDAGOGICAL UNIVERSITY OF KRAKÓW

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# Abstracts





# Vocabulary communication test practise in the subject of “mole” at secondary school education

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Keywords: Vocabulary Communication Test, Chemistry, Misconceptions.

This project has been designed for 9th grade students in the subject of mole with the method of Vocabulary Communication Test (VCT) to search their cognitive structure of pre-lecture and post-lecture of the subject, to identify the misconceptions that they possess and to see the influence of misconceptions which the lesson materials prepared accordingly. The research group has consisted of 30 students from Cumhuriyet High School. In order to come forth the map of cognitive structures of the group related to “Mole”, VCT has been practised as a pre-test and post-test. By aiming of constructing this map, it has benefited from the frequency that belong to the key concepts which the students have written that take place in VCT. At a result of the pre-test, it has been figured out that the students have written many concepts, as the students could not relate the inter-concept relations, their pre-knowledge of the subject has been found inadequate. At a result of the final test, it has been found out that they have produced more scientific answers but the answers to the given key concepts have become less. The key concepts that they have given meaning have rather increased. With the prepared materials the misconceptions have been prevented after the subject was taught. At last, the results have been discussed from the chemistry education point of view.



# Forensic geochemistry of hydrocarbon related contaminants in the marine sediments of the Niger-delta basin of Nigeria

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Key words: forensic geochemistry, marine sediments, Niger-Delta basin, and hydrocarbon

Nigeria has a coastline of approximately 853 kilometres facing the Atlantic Ocean. The coast is composed of four geomorphology units namely; the Barrier-Lagoon Complex, the Mud Coast, the Arcuate Niger Delta, and the Strand Coast. In 1956, Royal Dutch Shell discovered crude oil at Oloibiri, a village in the Niger-Delta, and commercial production began in 1958. Since the last five decades, some empirical literatures have documented the negative environmental consequences of crude oil exploration and exploitation, following the horrific incidents oil spillage in many Niger-Delta communities (Aghalino, 1999; Ekp, 1996). Environmental degradation in the Niger-Delta has been a major source of intractable conflicts that have severely affected the socio-economic and political development of Nigeria. Despite the various attempts made by many N.G.O's and International organizations, such as the United Nations to bring environmental justice to the affected areas, very little has been done by the concerned multinational oil companies to take full responsibility for their actions. From a scientific point of view, it is likely that this may have been due to the huge lack of extensive experimental or analytical procedures for obtaining scientifically proven, and court admissible evidences to help resolve environmental related legal disputes in the region. The purpose of this study is to demonstrate the theoretical applicability and empirical utility of environmental forensic geochemistry as a scientific methodology for identifying various hydrocarbon related, and other potentially hazardous contaminants, their environmental sources and time of release in the Niger-Delta area. The study will also investigate the various organic sources of hydrocarbon such as biogenic, pyrogenic and petrogenic sources, which are host to PAH (Polycyclic Aromatic Hydrocarbons) distribution in the study area. PAHs are produced in all processes of incomplete combustion of organic substances. It is anticipated that this will show how forensic geochemistry could be used as a monitoring mechanism for investigating the distribution of hydrocarbon contaminants, by linking them to their respective environmental sources to resolve environmental related disputes.

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# Design, Development, Implementation and Assessment of a Hybrid Course on Molecular Symmetry – A pilot project

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Keywords: improving classroom teaching, interactive learning environment, hybrid course, molecular symmetry

In this paper we present a hybrid course of molecular symmetry which was designed, developed and implemented at our department by incorporating traditional face-to-face teaching with effective pedagogical use of web based distance learning technologies (Garrison & Kanuka, 2004; Graham & Dziuban, 2008).

The educational material was organized in modules and implemented in the Moodle platform (CMS). Each module contained lecture notes, learning activities and knowledge assessment quizzes. Lecture notes were available in printable format and interactive html format with extensive use of molecular visualization educational software that we designed and developed for this purpose (Antonoglou et al., 2008).

Conclusions on effectiveness of the pilot project were obtained by comparison of student's performance and withdrawal rates during the hybrid course versus the traditional course. A questionnaire was distributed to students regarding their attitudes and beliefs towards the hybrid instructional model, course's material and their experience on the learning environment. Supplementary data about students' usage of the platform, the frequency of access to course material, their engagement to learning activities and their performance were retrieved from Moodle.

The results evidenced better students' performance and equal or decreased withdrawal rates within the hybrid course. Students ranked the hybrid instructional model as well as their hybrid learning experience as positive. The course met students' requirements for convenient course offerings, flexible scheduling, access to educational material for meaningful learning without time and place constraints and mutual interaction with the instructor. Dates corresponding to quizzes' deadlines and lecture notes uploading, showed an increased student engagement with particular online distributed course material and activities. Interactive lecture notes and learning activities that embedded molecular visualization applets were the most visited resources. During the semester a decline on students' visits to Moodle was observed.

Assessment results provide guidelines for revisioning, updating and supplementing hybrid course content and embedded learning activities, focusing on student participation in both face-to-face and on-line sections as well as on students' collaboration.

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# Developing a context based curriculum in The Netherlands

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Keywords: curriculum development, chemistry education, context based, secondary schools, final examination, assessment

**Introduction** During the last 10 to 20 years European countries have had problems engaging students in science (Osborne and Dillon, 2008) The number of students taking science in secondary schools and university dwindled. These problems have also occurred in the Netherlands. To make students more enthusiastic for a science a movement for the renewal of science education has started (Driessen and Meinema, 2003) This renewal is based on developments in other countries, such as Salters in the UK and Chemie in Context in Germany (Pilot and Bulte, 2006) Central in these renewals is the use of contexts to introduce science concepts to students. A context is defined by van Oers (1998) as a sociocultural setting in which goals and operations are to be valued in the framework of that activity. Some contexts used in the Netherlands are about ‘combustion’, ‘food’, traveling etc.

**The experiment** From September 2007 experiments are carried out in about 20 schools using learning units that have been developed in the past years. The main question is whether a context based curriculum using these units leads to a certain level of scientific literacy, and sufficient knowledge to be used in further education. Based on these experiments a national context based curriculum will be proposed. The learning units used for context based education. The learning units have been designed using a general format, having a number of different phases based on the CHIK format (Parchmann et al, 2006).

**Final examination** During the experiment the students take tests within the schools, designed by the teachers. At the end of the course a central examination (in 2009 and 2010) is taken by the students to determine their progress. In May 2009 the first central examination was held. The results of this examination will be discussed and compared to the results of students that did not take part in the examination. One third of the examination was the same for all students, one third was slightly adapted and one third was special for the students in the experiment.

**Results** The students in the experiment scored about the same on the part that was the same for everybody. They scored lower than expected on the adapted parts. The score on the final examination was on the average the same as the score on the school exams.

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# Comics as resource to tell a scientific concept

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Keywords: comics, pre-service science teacher, cultural tool

Considering a sociocultural approach we recognize that learning involves being introduced to a symbolic world. Knowledge and understandings including scientific understandings are constructed when individuals engage socially in talks and activity about shared problems or tasks (Driver et al., 1994). It is fundamental that the teacher investigates what are the situations that could create interest and how it can be worked and articulated to the scientific topics, because it becomes a convincement act by showing to the students other ways to dialog about the reality (Driver et al., 1994).

Comics are pictorial images and graphics juxtaposed in a deliberate sequence destined to transmit information and/or to produce an answer in the reader. When completely explored, words and illustrations have an enormous power to tell stories and to transmit messages. The students participate actively by using their imagination to fill out the spaces between the pictures (MacCloud, 1993). The use of the comics, besides sending to situations of the student's daily life and of their social life, makes possible the reflection on the proposed theme, the confrontation of ideas, the search for solutions and alternatives and the autonomy in the learning use by computer (Rota, G.; Izquierdo, 2003).

This work describes the experience of producing comic strips by pre-service science teachers. The data analyzed were the comics about environmental problems produced by them and some interviews. Most of them produced comics supported by words, but we have to pay attention that for the 6-7 years old the communication of students is more based in images and representations. The positive aspect this accurately in the possibility of the use of the comics as resource that through the images can facilitate the understanding of a concept, that is, the following relation: ecologically correct attitudes would allow an ambient improvement.

In this manner comics while cultural tool allows the comprehension of meanings and also the elaboration of others which belongs to a particular social group. As a cultural tool, the comics, besides working with different situations proposed by the narrative and with different images composed of characters, can involve the students in other areas of knowledge.

According to our results most of the comics produced are quite similar than the comics produced by students (Santana, Serra and Arroio, 2009), it means that we have to develop this methodology during their training courses.

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# Nature of science in science education: audiovisual context based

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*keywords: cinema, younger's education, ICT, science teaching*

Motivation, to be successful, and science education is no exception, has to rely on a rich repertoire of experiences on which to build conceptual learning. These experiences pave the way to the construction of meaning, which in turn supports learning. It also helps to entertain, create or re-create a sense of wonder, which becomes the true incentive for learning.

It is therefore important to think of education systemic term, not limiting the student's experiences to what can possibly take place in the classroom. The role of alternative learning environments therefore becomes critical as a prelude, a complement a follow-up to the school-based learning process. Experience comes from interaction with a learning environment (Arroio, 2007).

Science educators are in constant battle to change the preconceptions of students who are inspired – and confused - by the movies and television programs they see. But, these movies also open an amazing opportunity to engage the students and encourage greater understanding and interest.

This purpose explores the effect of using movies on the learning and retention of simple and integrated science knowledge about the nature of science. Based on the socio-interacionist approach by Vygotsky, it is acceptable that an audience can interact with the characters and share their emotions and actions showed in an audiovisual language. According to Vygotsky (1978), the language mediate the cultural transmission process of knowledge acquired by humanity, without the language, is it almost impossible that teacher's words make sense for students. Socio-cultural theories of learning draw on Vygotskian theory can provide a way of considering these issues in terms of the way ideas developed on the broader social plane of the classroom may be appropriated by individual learners (Arroio, 2007).

On this way we analyze some movies considering the potential of audiovisual, scientific and common languages to be used as a tool to mediating science teaching and learning. According to this study, the film dealing with genetic engineering raises issues of identity and genetic determinism. This film extrapolates on the basis of know science to achieve a representation of real as opposed to fictional problems. And give us one opportunity to discuss how our genes determine behavior and control the development of capacities.

Science is a complex of specific, situated human social and cultural activities. Science as a total system of social activities is not merely research science; it includes all the use of scientific practices in the workplace, in the home, in the environment. It is science as science is done and used by those who are trained to use it according to the norms of our society. Science alone will not make the world a better place. Learning the results and methods of scientific research will not in itself help students make better lives for themselves. We must all learn to understand how science and science education can help us help ourselves.

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# The effect of active learning based science activities on students science achievement

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Every country in the aspect of the general goals of their education, they generate specific educational programmes to train the pupils to the aimed level. One of these programmes is science education programme. In recent years, the main idea of the researchers is the pupils learn science better if the learning process is based on researching and pupil centred. (Schneider, 2001). Also the pupils should be stimulated to improve their up-most thinking skills; to write and talk over what has been learnt according to the nature of learning science and technology as the nature of the learning process is an active period.

**Methods** The pupose of this study was to determine the effect of the active learning based science activities on eight grade primary school students' achievement. This research was conducted in a quasi-experimental design by using pre-test and post-test with a control group during the academic year of 2008-2009. The students in the experimental group were instructed by the active learning based science activities. On the other hand, the control group was instructed according to Turkish National Science and Technology Curriculum. 64 eight grade primary education students participated in the student study group in all, consisting 31 students in the experimental group and 33 students in the control group. The participants are 8th grade students from a public school in İzmir, Turkey. "Science Achievement Test" were used as pre-test and post-test for the experimental and control group. In this research, "Science Achievement Test" developed by researchers was applied as a pretest and posttest in order to make a comparison between the students' achievement in terms of knowledge, comprehension and application levels of learning. The scale consists of the learning level of the units "Organisms and Energy Relations" and "States of Matter and Heat" and the study lasted for 10 weeks. This instrument is composed of 59 items regarding students' achievement in four point likert type. The KR 20 value of this 59 items was 82. Independent groups t-test analysis technique was used to analyse the data.

**Results** According to the results of t-test analyses of "Science Achievement Test" before the instruction, there was not any significant difference between the science achievement scores of the research groups. To understand the affect of active learning based science activities on students' achievement independent group t-test analysis was concluded results were presented on Table 1.

Table 1: Control and experimental group student' 'Science Achievement Test' post-test scores

Groups	N		SD	t	p
Experimental group	31	38,96	6,2	2,802	0,007
Control group	33	35,3	3,9		

The results of t-test analysis about 'Science Achievement Test' questionnaire after the instruction show that there was a significant difference between the experimental group ( $M = 38.96$ ,  $SD = 6.2$ ) and the control group ( $M = 35.3$ ,  $SD = 3.9$ ),  $t(64) = 2.80$ ,  $p = .007$ . So, according to post-test grades obtained from "Science Achievement Test" there were statistically significant differences supporting the experimental group ( $p < .05$ ).



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# „Intelligent Fertilizers“ – Experiments for the school lab with everyday-life-chemicals

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Keywords: Fertilizers, controlled release, experiments with fertilizers

**Background** The topic „fertilizers“ is well known in school chemistry and biology. Simple experiments like the detection of cations such as ammonium and anions such as phosphate are a good introduction to some aspects of analytical chemistry ranging from the use of sticks to classical anorganic reactions (e.g. Bader & Blume, 1997). The benefits of fertilization and the dangers of overfertilization are discussed in both chemistry and biology lessons.

The problem of overfertilization can be partly solved by controlled release fertilizers (Dittmar et al., 2009). This is not only a way to solve environmental problems but it is a benefit for farmers too, who can save money by the need of less amounts of fertilizers. Seen from the point of view of school chemistry this is a good example to show how to solve environmental problems with chemical know how.

**Methods and Results** Controlled release of fertilizing agents can be achieved by different strategies. For school chemistry the coating of fertilizers and the use of carriers are most interesting and easy to understand. In addition hands on experiments can show the principles of controlled release. Fertilizer products of garden markets are cheap chemicals to start with.

Experiments show the effect of controlled release of coated fertilizers by detecting the change of conductivity when mixing such fertilizers with water. Coating of (uncoated) fertilizer-pellets can be carried out with wax. This leads to a product where the rise of conductivity of an aqueous solution is shown in half an hour – a good time for chemical lessons. The detection of the components of different fertilizers is well known in chemistry.

Controlled release based on ion-exchange resins is the second type of fertilizers to be examined. Students are surprised to find out that one can detect typical cations and anions just by rinsing these fertilizers with distilled water: There is a layer of water soluble salts on the surface to achieve a rapid increase of fertilizing agents in the beginning. After removing this layer the desired cations and anions are only released in exchange reactions for instance potassium versus sodium. Further experiments lead to the composition of carriers: The mixture of anion- and kation-exchange resins can be separated by mass density with a sodiumchloride solution.

Most of the experiments are quite simple and can be carried out by secondary school students. In connection with biology lessons it provides some new aspects to a well known topic of school chemistry.

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# The Assessment of Science-Technology-Society (STS) Subjects in Science and Technology Book Sets in Turkey

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Keywords: STS, primary education, science and technology book sets

Nowadays the scientific and technological developments affect all areas of our life. Students who will make important decisions in the future must be sensible to these developments and also must be conscious citizens for the future. For this reason it is expected that students are individuals who use information and also produce it instead of being passive recipients. They have to make ethical decisions using skills like scientific, critical and creative thinking, problem solving and using technology for the problems which they faced. Consequently scientific, technological, social and environmental subjects should be taught them in early years. The main objective of teaching science should extend itself beyond the scientific contents and recognize the role of science and technology as a method of solving the problems of humanity.

The effects of scientific discoveries and technological innovations on the society made a new approach which focus on the relations between the nature of science, technological innovations, social and environmental problems necessary for the science teaching. One of the reasons to use science-technology and society (STS) approach in science teaching is to provide students having social responsibility to decide common decisions to solve problems dealing with science and technology.

One of the most important developments in science and technology education is the progress of the curriculum. Because this progress will affect all of the students' future indirectly. In Turkey the curriculum for science and technology is one of the important studies. The vision of this curriculum is explained as to provide all students being science and technology literate without looking their individual diversities. The Science-Technology-Society-Environment Relations is one the seven learning areas of this curriculum. The acquisitions of this learning area are related with the units' acquisitions in the curriculum.

On the other hand book sets consisting of textbook, student work book and teacher guide book are written according to the curriculum. Books are one of the most important and powerful tools in lessons. And so in this study the science and technology book sets for 4-8th class in primary education which have important effects on students' future were examined. Thus 15 books consisting of textbooks, student workbooks and teacher guide books have been examined. It was used survey model for the research and STS subjects in the book sets were evaluated with qualitative analysis. For this reason content analysis was used. The obtained data were interpreted in the tables. The style of presenting subjects, the relations between contents and acquisitions of science-technology-society-environment learning area and also social dimensions of the examples on physics, chemistry and biology parts were evaluated.



At the end of the research it was found that there are some special parts in the book sets for STS subjects. These parts include several problem cases and original questions related to them for physics, chemistry and biology areas. Some advices were offered according to data at the end of the research. It is expected that these advices will be guide to other books which will be written in the country and abroad.

## **Motivation in learning chemistry**

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Motivation is a key element of education and play crucial role in the success of the learning process. There are two kinds of motivation:

Intrinsic motivation occurs when people are internally motivated to do something because it either brings them pleasure, they think it is important, or they feel that what they are learning is significant.

Extrinsic motivation comes into play when a student is compelled to do something or act a certain way because of factors external.

The article presents the results of research concerning the students intrinsic and extrinsic motivation for learning chemistry.



## New technologies in chemical education

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Keywords: interactive whiteboard, interactive response systems, document camera, the Nature,  
Chemistry, teaching, learning

*Imagination is more important than knowledge.*

*Albert Einstein*

Breakthrough discoveries are made in hundreds of universities and research institutes all over the world. Mobile phones, laptop computers and the Internet have become the tools for our work, entertainment and communication. They are used by younger and younger children. Seventy-two percent of parents of children over three years of age confirm that their children use the computer for playing games and surfing the Internet [1]. Children and teenagers (7-14 years of age) spend on average 49.5 hours in front of the computer every single month [2]. An average person spends about twenty percent of their time at school or university. The education one obtains is mostly inadequate and therefore it is so important to develop a positive attitude towards one's further development and education. At school, students should first of all learn the following skills:

- Independent learning and using technology,
- Adjusting to changes caused by technology.

The role of teachers is to:

- Assist students in developing their skills of independent learning,
- Continuously develop their own professional competence, also this pertaining to technology [3].

In order to promote the above approach amongst students, teachers must be able to integrate and support innovation and technology in teaching their school subjects. Therefore it is so important to present the possibility to teach those subjects with the use of new didactic means as well as to create curricula, or even classes, integrated with the available equipment such as computers, interactive boards, knowledge testing systems, document cameras and interactive response software.

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# Pre-service Primary Teachers' Opinions on Factors Contributing Students' Failure in Science

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Low level of student achievement in school science is a problematic issue in Turkey as in many countries in the world. Students' success in science and mathematics in the university entrance exams is considerably lower than the other subject areas. For instance, in 2008 University Entrance Exam, the average of correctly answered science questions was 3.9 out of 30 questions. Similarly 6th grade Level Determination Exam results revealed that the average score for science is 6.39 out of 16 questions. The International exams also confirmed the situation. For example, in Third International Mathematics and Science Study (TIMSS) which was held in 1999, Turkey ranked 33rd out of 38 countries in Science. In PISA -2003 assessment, Turkey ranked 36th out of 41 countries. In the later years Turkey was improved relatively. In 2006 PISA Turkey ranked 44th out of 57 OECD countries. According to TIMSS 2007 Turkey ranked a little higher. However, still it is clear that students' achievement in science is relatively low in Turkey. The studies investigating students' perceived reasons for failure in science revealed that, students think that they fail in science subjects because: they don't believe that they can be successful in these subjects, they don't find science related to the real life, they cannot actively participate in the class, the concepts covered in these classes are abstract and hard to learn, and they don't know how to study these subjects.

Primary school teachers are the persons who introduce students with science formally. Teachers' role is vital in improving science education in Turkey. First of all they should be trained well. Their perceptions of what factors effect students' achievement would be also influential on their practices in teaching science. The present study investigates student- teachers' opinions about the reasons for the failure of science education in Turkey and their suggestions for improving science achievement.

Student teachers were asked to answer 2 questions by writing:

1. What are the reasons for students' low level of success in Science?
2. What can be done to improve student achievement in science?

One hundred and eighty six third year primary teacher education students participated in the study. Student-teachers' written responses were analyzed by content analysis. According to the results most frequently reported factor for the failure in science classes by the student-teachers is the students' negative attitudes toward science. Another important factor according to the student-teachers is the teachers. Several attributes of teachers were mentioned as affecting the failure such as their not being trained well in science, insufficient preparation for the class, not using adequate teaching techniques, and depicting science as a very difficult subject that cannot be succeeded by most of the students. Another factor identified by the student teachers is the physical conditions of the schools in Turkey, for example, in many schools laboratories do not exist or they were not equipped well. Student teachers' suggestions to improve science education were mostly focused on the teaching techniques such as using variety of teaching techniques, doing more laboratory experiments, using cooperative teaching techniques, project based learning, using more technology in class, and outdoor education.

## Thermal imaging in teaching elements of thermodynamics

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Keywords: adiabatic process, adiabatic compression and expansion, infrared camera, thermal imaging.

We propose using thermograms while teaching about heat processes with temperature change. The consecutive thermograms illustrate adiabatic compression and expansion of the air. We use balloons, balls and bicycle pumps, and an infrared camera. We also show a recording from an infrared camera, of a cycle of energy changes in the drinking bird toy. For comparison we show photographs obtained with a standard camera and with infrared camera.

We present the thermal images taken with the infrared camera Flir ThermaCAM SC 640, obtained in Division of Physics and Chemistry of The Main School of Fire Service.

We show several thermograms that can be used in school in lessons of primary science, physics and chemistry.

Thanks to visualization of temperature, teaching of thermal processes in school is less abstract and easier to understand.

## Research on pupils' ideas on the structure of oxides using a computer program

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Oxides are one of the simple groups of chemical compounds since they are composed of two elements. The structure of oxides is not uniform. Some oxides have molecular structure and some are built of ions. Rules, which oxides have ionic structure are very simple and therefore their usage by pupils should not cause difficulties. A computer program was constructed and used in order to test what image of the structure of oxides have pupils in the Czech Republic. This work shows the results of the research.

# Teacher of Natural Sciences for Lower Secondary Education from Czech Perspective

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Keywords: teacher of natural sciences (chemistry), school reform in Czech Republic, integration in science education, inquiry based teaching and learning.

The new conception of curricula, especially with the emphasis on key competences, enhancement integration and trans-subject relations, wider rate of differentiation, application of new topics, will considerably increase requirements on both schools and teachers and will call for continuous preparation and support. This is one of the main objectives of suggested infrastructure and part of “Curricular policy of The National Programme of Educational Development in the Czech Republic (White book)”. There can be seen that topics on integrated natural science education are topical and important ones (Nezvalová, 2005).

The fate of the chemistry education or as it is mentioned in new general curriculum the chemical nature education has been so far very uncertain. Will chemistry remain the only subject, which is not taught in all grades? Will there remain various nature science subjects at the secondary school or will prevail the model of one integrated nature science in the upper grades of the primary and the secondary school? These are some of our expectations or questions the answers to which we have not got but we are trying to find (Bílek, 2009, Nodzyńska, 2009 etc.).

Meaningful answers can bring an improvement of teachers preparation, teachers continuing education and support of educational processes (Bílek, Slabý, 2005).

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# Real and Virtual pH-meter in Early Chemistry Education

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Currently the real life brings more and more virtual environment items, new virtual worlds etc. The school experiment is to be purposeful, i.e. clear, appropriated to pupils' age, simple, well organized, visible and safe. The objective of our research project is to discover possibilities and their limits in the use of virtual environment supporting early chemistry education (Bílek et al., 2009). It means to research effectiveness of the computer simulations and animations applied in early chemistry education (basic school, grades 8 – 9), either independently, or in various combinations with the real experiment. The core of the research is to conclude relations and recommendations for meaningful and effective use of computer simulations and animations, remote and virtual laboratories, etc.

The basic school pupils will undergo a pilot research on laboratory pH measuring supported by real and virtual (simulated) apparatus, i.e. a virtual pH-meter, which is an available simulation on T. Greenbowe Web page (Greenbowe, 2009), and a hand pH-meter in real set on the laboratory desk.

Two as much as identical scenarios were prepared using either real or virtual pH-meter, managed by worksheets containing tasks of three levels:

Level 1: simple pH measuring in three samples of selected chemical matters (hydrochloric acid, sodium hydroxide and sodium chloride) in three different strengths.

Level 2: answers to problematic questions followed by their verifying by measuring changes in parameters of the matters (strength, volume, similar chemical matters), e.g. What pH value will a certain volume of hydrochloric acid solution reach having lower/higher strength than in previous measuring? How will pH sodium hydroxide with strength of 0.06 mol/dm<sup>3</sup> change when its volume increases from 100 ml to 150 ml? What pH value will potassium hydroxide solution reach in comparison to sodium hydroxide solution if the strength is the same? Etc.

Level 3: open task, e.g. Design and describe assignments and results of other tasks which you could do with the provided aids and real or virtual chemicals. You can ask your teacher to provide you with other chemicals and aids for the real experiment, or with advice on other functions of the simulated pH-meter for the virtual experiment.

The following hypotheses were set for this research: (1) No statistically significant differences will appear in pupils' results of pH-measuring in provided solutions of chemical matters with the real and simulated pH-meter. (2) Statistically significant differences will appear in pupils' answers to problematic questions dealing with pH-measuring in solutions of concrete chemical matters by the real and virtual pH-meter. (3) Pupils' recommendations on using the laboratory arrangement for other measurements will be more frequent and varied, i.e. more proposals will appear, and the teacher will be asked more questions related to the real environment than to the virtual one.

The first received results will be presented and discussed on the conference poster presentation.



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## Coping with diversity in and outside the classroom

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Since many years, especially since PISA, teachers have been requested to reflect possibilities of individual learning in chemistry lessons (Guo, 2007). Several approaches coping with students' individual cognitive and epistemological conceptions have been developed.

Taking into account that students participating in national competitions are particularly heterogeneous because they come from schools all over the country, they are of special interest.

In North-Rhine Westfalia there is a competition "Discovering Chemistry" (Schumacher, 1998-2009) which addresses secondary lower level students. Up to now nearly 65000 participants can be registered, covering all different school types. But as statistical analysis reveals comprehensive schools make only 1% of them. Since this competition aims at motivating especially poor learners by confronting them with open learning environments and authentic experiments (Hodson, 1998; Woolnough, 1998; Rennie, 2007) the low participation is revealing.

Starting from this result the idea was born to develop special programs in order to enhance the number of participants on the one hand, and to integrate the programs in every school day on the other hand to cope with diversity.

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# Divuligation of science in the classroom: an analysis of students interactions with texts from newspapers and magazines

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Keywords: Divuligation of science, science education, perception of science and technology

**Background, framework and purpose:** Bakhtin (1979, 2003) emphasizes the importance of the dialogical relations in the texts in which the subject acquires meaning in its relations with the other. In Bakhtin's dialogism it is vital to recognize the presence of the other, of that to whom one speaks. The sense and the meaning of the enunciation, in order to be understood, require that the dialogism be established. For Bakhtin (1979), words are not neutral; rather, they carry a meaning that is established at the time they are inserted in certain discourses. Every discourse is founded in a place because there is always a responsive aspect in language. Our individual consciousness is contaminated by the other's word, and the other's voice is present in our discourse. Discourses are always directed to someone—their interlocutors—and they do not exist by themselves but as an act of enunciation. In this sense, no discourse is void of ideologies, values, perceptions, in other words, of the characteristics of those who write them. In a similar way, the understanding of discourses also happens in accordance with the perceptions and signifying of the person who receives them. The discourse of the divuligation of science is permeated by perceptions and conceptions of science and technology, both by those who write them and those who read them. Therefore, the study of perceptions and interpretations which the students ascribe to the divuligation of science is an important factor for the analysis of the relationships between formal and informal education because both promote the formation of the individual's scientific culture.

**Method:** This study is part of an investigation that has sought to understand the perception of the students about the divuligation of science as it happened in texts published in Brazilian newspapers and magazines, whose aim is to make science a more accessible topic. There were activities where the students interacted with the texts of divuligation of science in classroom during 2007. These activities took place in the classes of the second year of secondary level (equivalent to high school) in a public school from the city of Sao Paulo in Brazil with 34 students during chemistry classes. All the activities were recorded in audio and video and, after a selection, some episodes were analyzed.

**Results:** From the analyses it was possible to observe that students have difficulty in undertaking a critical reading of whatever is published by the Media. Also, they do not perceive the texts of divuligation of science, as done by newspapers and magazines, as informative. Instead, they expect that these texts provide them with all the answers about science and technology about the topic that is discussed. They regard such texts as truthful, dispensing with any objection.

**Conclusions and implications:** Our investigation has led us to the conclusion that it is necessary to develop classroom activities with such texts in a critical reading, promoting the understanding of this gender—divuligation of science—because it should not be seen in a non-critical way without an analysis of the context in which it is produced. Furthermore, it is necessary that the students understand the divuligation of science as a product of the media and that, as such, it satisfies the requirements of this realm. The absence of a critical reading and of the understanding of the divuligation of science as a product of the media, at times, lead the students to a mistaken or misrepresented perception of science and technology, which may have implications in their general and educational scientific formation.

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## **Constructing a close-ended questionnaire to illustrate Greek students aged 15 and 17 years conceptions about energy**

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Keywords: science education, energy, questionnaire construction

Energy is one of the most discussed and most researched concepts in science education (Schmid, G.B., 1982, Trumper, R., 1997, Boo, H.K., 1998, Papadouris, N et al, 2008). This is mainly for two reasons. First, energy is one of most fundamental science concepts, which unify physics, chemistry and biology. Second, energy holds an important role in global and topical social and environmental issues. The purpose of the study is to construct a questionnaire examining the ways in which Greek students aged 15 and 17 years, account energy in various physical, chemical and biological phenomena.

To conduct a large scale research, it is of crucial importance the construction of an appropriate questionnaire in order to meet the purpose of the research. In this study we followed the protocol for the conduction of educational research (Tuckman, B., 1999).

A close-ended questionnaire was constructed, as following: (1) concept analysis in order to find out the aspects of energy concept, (2) curriculum analysis in order to find out what Greek students had taught about energy concept during the teaching of Physics, Chemistry and Biology and (3) literature review in order to find out students misconceptions about energy and also the researchers' methods to explore this (Duit, R., 2009).

We have constructed a close-ended questionnaire, (Frey, B. et al 2005, Rodriguez, M. 2005), which, was administrated to 150 students aged 15 years and 150 students aged 17 years. Simultaneously we administrated the questionnaire in 10 science teachers in order to identify for each question: (a) which is the right answer, (b) which aspect of energy concept concern and (c) which branch of science concern.

The questionnaire had a Cronbach's alpha of 0.80. We performed the questions analysis and derived the questions that were appropriate for the final research. In order to evaluate the questionnaire, the science teachers' questionnaire results were also taken into account. Taking into consideration the above results, the final questionnaire was constructed.

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## Reflective diary in Polish context. Does it works?

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Keywords: chemistry education, university education, learning logs

Reflection over study mode is quite rare among average students. In order to promote intellectual effort learning logs/reflective diary were introduced (Audet et al, 1996; Babcock, 2007; Byers, 2007, ). In the academic year 2009/2010 the Faculty of Chemistry of the Jagiellonian University in Krakow introduced a new course – “Basic bioinorganic and structural chemistry”. It was organized in an innovative way. Each group of 25 students was divided into 5 smaller ones. Within the first assignment students worked with printed materials distributed by the academic teachers. Each group was given another topic and all topics formed a broad theme (thus scrupulous work distribution played an important role). The course ended with multimedia presentations delivered by each group. The final task groups were charged with was to write a summary of their work and distribute the summaries among the rest of the students. In between classes students were asked to keep a reflective diary and answer the following questions:

1. What have I learned today and how does it relate to my previous knowledge?
2. What was my contribution to the group work?
3. Plans – what am I planning to do? (e.g. recall specific knowledge acquired in other courses, verify a fact, ask a question, have a discussion with someone, etc.). My conclusions drawn from today's class that may appear helpful in the future (concerning my work in the class, preparation to an exam, etc.)



Reflective diaries were analyzed. Afterwards students were asked to fill in an evaluation survey that aimed to reveal their opinions on the new teaching method (group work, delivering presentations, listening to presentations, writing summaries, analyzing summaries received from other groups, reflective diaries) and its influence on remembering, understanding, acquiring new skills and solving problems in a particular area. Special attention was paid to students' views on group work. In the survey section concerning reflective diaries students were asked to evaluate the questions difficulty level as well as the aim and effectiveness of the task, i.e. whether reflective diaries indeed evoked reflection over their study mode and, if yes, what the reflection was. 42 students participated in the survey, i.e. 84 % of two groups.

Survey results analysis revealed that the question concerning contribution to the group work was the easiest one. However, over 50 % of the questioned did not write anything more than: "I was doing what others were doing", "a group member", "same as others", whereas in their reflective diaries they would put a detailed description of tasks they had to fulfill – exploring a given topic and presenting it to other group members.

In contrast to the results presented above (Byers, 2002) reflective diaries were not received as enthusiastically as in Ireland. Almost half of the students (17 out of 42) stated that keeping the diary did not make them analyze their study mode. Reflections described may be categorized into the following general groups:

- the need of systematic work and work management
- the need/significance of using knowledge acquired in the past, verification of knowledge
- study mode applied so far considered the best

Out of 42 students, 14 (over 30%) were not able to determine the purpose of keeping diaries, while to others it was systematization of the acquired information, identification of deficits in knowledge, learning how to select information and work management.

It is absolutely necessary to present students with the idea and purpose of keeping a reflective diary in a more convincing way and to systematically provide feedback (after each class) on the students' reflection.

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# How science students understand, remember and use mathematics?

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Keywords: mathematics for science students, conceptual and procedural knowledge, teaching calculus

Practically all science study programmes contain mathematical courses. They are meant to give the students mathematical tools they should be able to apply later in applied contexts of their specific study area. This can only be attained if the students remember the concepts after they have completed the corresponding courses. It is often noted that students who have successfully completed their mathematics courses, often containing quite sophisticated mathematical topics, are in many cases unable to correctly apply them in a concrete context. One of the reasons could be that students tend to learn their mathematics courses as separate entities, and are thus often unable to apply a mathematical technique learned (and successfully tested on in the mathematics course) in the real applied context. Another, and the authors conjecture that this is the main one, are overloaded syllabuses, particularly characteristic for the Croatian educational system, which facilitate the retainment of procedural, and less of conceptual knowledge. As both types of knowledge are necessary to successfully a mathematical concept, an affirmation of this conjecture would explain the noted problems, and suggestions for improvement could be made.

As the content of mathematics courses varies from study to study, the authors decided on testing the retainment of knowledge in basic calculus (derivatives and integrals), as this topic is covered in all of the mathematics courses for science students. The authors have made several surveys testing the retained level of knowledge about derivatives and integrals at two Croatian and one Danish university. Also, the first-named author, teaching the mathematics courses for chemistry students in Zagreb, has tried to incorporate more applications of derivatives and less mathematical formalism in the mathematics course, thus making it less a separate identity in the learning process. The outcomes of this approach are still to be tested. After statistical analysis of the surveys, the results support our conjectures.

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## Teaching chemical thermodynamics: with or without mathematics?

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Keywords: teaching chemical thermodynamics, mathematical models, interdisciplinary teaching

Chemical thermodynamics is one of the subjects in chemistry that are at the same time fundamental to understanding of chemical processes and (not only) mathematically quite complex. Depending on the school level, one can choose between various approaches for teaching chemical thermodynamics, from purely intuitive to the mathematically formal. Chemistry students learn about chemical thermodynamics in corresponding courses in physical chemistry, usually after they have completed the prescribed mathematics courses. Thus, they should be able to relate the mathematical concepts to the physicochemical phenomena.

Many chemists feel that the mathematically formal approach is directly opposed to the more phenomenological, and complain that by using the mathematical formalism one loses the understanding of the processes. The „other side“ often uses the argument that the intuitive, phenomenological, approach is not exact. Depending on the teacher's preferences and the prescribed curricula, students usually learn to deal with chemical thermodynamics either predominantly with or without much mathematical formalism, and even if the classes offer both approaches at the same time, they mostly exist as two parallel approaches: there is a definite lack of connections and understandable interrelations between the two versions of describing thermodynamic concepts, even in literature. An additional problem is that many students forget, or even never learn, how to mathematically model real-life phenomena by the mathematical techniques they learn in the corresponding mathematics courses.

We demonstrate that the two approaches are not mutually exclusive, but go hand in hand, and that neither one can be self-sufficient. At university level, there is no need to exclude the mathematical approach, since the students have sufficient mathematical background to use and understand it. There is a necessity to improve the quality and in some cases the content of mathematics courses, in order to enable students to understand and develop mathematical models and their limitations. Even more, teachers of physical chemistry should have sufficient mathematical training in order to be able to explain when a mathematical model is sensible, why it is so and what are its limitations.



Our claims are founded on informal interviews both with chemistry students and teachers, on results of exams in mathematics and physical chemistry courses, and participant observation in student groups and in the meetings of the Educational section of the Croatian chemical society. The first-named author, being a lecturer for mathematics courses for chemistry students, has incorporated some of the chemical thermodynamics topics that are modeled by multivariable calculus techniques in the mathematics lectures; the effects are still to be tested.

We hope to give suggestions to chemistry teachers how to decide on whether a mathematical model is appropriate and if it is, what are its limitations due to the fact that every mathematical model is only an approximation of reality and is only reliable if the presumptions it was made under are valid.

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## Theoretical Study of Alkaline Hydrolysis of Ethyl Acetate

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Keywords: alkaline hydrolysis, aliphatic ester, AM1

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 ethyl acetate hydrolysis, aliphatic ester, 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. Energies, lengths and binding angles values obtained were compared with experimental [2] and bibliographic [3], data. Following the same procedure it was identified the geometric parameters and energie of reaction intermediate. The activation energy was 10.07 kcal/mol.



Table: Geometric Parameters Intermediate

Lengths	Å	Angles	o
r (C1-O2)	1.49	(O3-C1-O2)	106.55
r (C1-O3)	1.35	(H16-O15-C1)	108.79
r (C1-O15)	1.34	(O3-C1-C4)	108.88
r (C1-C4)	1.48	(C9-O3-C1)	117.16
r (H-C4)	1.11	(H5-C4-C1)	108.73
r (H16-O15)	1.01	(C10-C9-O3)	110.99
r (C9-O3)	1.42	(H14-C10-C9)	109.67
r (C9-C10)	1.52		



Figure: Tetrahedral Intermediate

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# Integration the Nature of Science with Science Concepts at Science and Technology Curriculum in Turkey

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Keywords: The Nature of Science, Science Textbooks, Science Curriculum.

Integration teaching science with the nature of science help students in constructing of science concepts (McComas, 2007). Even though there is no a common definition for what science is, there are several characteristics of science which has been widely accepted. In order to give such understanding to students, teachers need to understand what is really embedded in the concepts of the nature of science (Wong, Kwan, Hodson, & Yung, 2009). For this purpose, science curriculum and textbooks must be redirected to reference the nature of science while they imply other scientific concepts. In Turkey, such efforts have been started with last shifting movements of science for creating competitive education system with developed countries (Ministry of Education, 2008). However, there is still need for developing curriculum with integrating the nature of science. In this study, it is aimed at finding out that how these efforts have ended in preparation of curriculum and textbooks. This is a qualitative research study. In this case study, Science Curriculum and Textbooks in Turkey have been compared with Conceptions of Nature of Science in lights of Turkish National Science Educational Standards (TNSES). Data were analyzed in terms of comparative analysis techniques (Patton, 2001). Considering the conceptions of the nature of science, TNSES have strong statements. The standards point out that scientific concepts should be related with the nature of science. While showing this guidance to teachers, it has little information in textbooks for classroom applications. The main issue in this area is that the curriculum avoids using the term of the nature of science in any other subject taught in a science course. Although the history of scientific knowledge and concepts is mentioned in class activities, there is no clear implication for the integration of scientific knowledge with the conceptions of the nature of science. Most of the problems is caused by lacking of direction in textbooks in terms of connecting any scientific knowledge with the conceptions of the nature of science. In the future, ministry of education could provide more insight for teachers in their teaching of science concepts with mentioning the nature of science.

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# Microwave Assisted Synthesis of Amides in the Presence Microporous Materials

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Solvent – free reaction are realized under microwave irradiation in the presence micro porous materials. These conditions can influence reaction yield or reactivity.

Well know microporous materials are zeolites - natural and synthetic aluminosilicates. Other materials are montmorillonites as phyllosilicates (smectics). The structure unit of the zeolites are SiO<sub>4</sub> tetrahedron and AlO<sub>4</sub> tetrahedron. This units form the spatial structures with the pores and the cavities. The structure and composition of the zeolites and montmorillonites are connected with their catalytic effect. The catalytic activity of the zeolites depend on the acidic active center. These synthetic laboratory methods can be also use in chemistry education.

Synthesis of amides under microwave irradiation in the presence of microporous materials in solvent-free conditions was use for teaching of chemistry. Reaction of the benzoic acid with aliphatic amines was selected as school laboratory experiment.

The reaction was realized in commercially microwave oven. The mixture of benzoic acid once aliphatic amine in the porcelain crucible, which is overlapped with watch glass were heated in the microwave oven.

The first product of interaction the benzoic acid and aliphatic amine is ammonium salt, which dehydrated to the amide. The reaction mixture contained also microporous material, for example zeolit.

Crude product of reaction was analyzed by thin layer chromatography (Silica Gel, impregnated luminescence indicator, chloroform, UV- lamp –  $\gamma = 254 \mu\text{m}$ ). Acids zeolite and montmorillonite had positive influence on results of synthesis.

These experiments show the contemporary trend in organic synthesis – green chemistry.

This trend is very significant also in the chemistry education.

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# Science education in Ireland: strengths and weaknesses

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Keywords: Ireland; science education; second level; practical work; CPD

**Background, framework and purpose** This talk will review science education in Ireland, with special reference to second level. It will focus on the take-up of science, the curriculum, the role of practical work, gender balance in science, and the initial training and continuing professional development of science teachers. For an earlier survey see Childs, 2001.

Science is now part of the Primary curriculum but only since 2003 and is taught throughout all six years of compulsory primary education. This is the only place that science is compulsory in the Irish education system. At age 12, pupils to second level and Science is one of the subjects on offer for the Junior Certificate. Science is not compulsory and is taken by ~90% of pupils, with more boys than girls taking science. This is the only Irish science course where practical work is assessed and given credit for.

The first national examination is the Junior Certificate after a three year junior cycle, where Science is one of the optional subjects. Junior Science leads to 5 Leaving Certificate subjects in the two year senior cycle: Agricultural Science, Biology, Chemistry, Physics and Physics with Chemistry. Each is offered at Higher and Ordinary level. Around 80% of Irish pupils proceed to the senior cycle and in 2008 >60% went on to some form of higher education. Within the Leaving Certificate cohort Biology is by far and away the dominant science subject taken by 51.8% of pupils in 2009, followed by Chemistry and Physics (both ~13%). (Childs, 2009) The three main sciences include a set of mandatory experiments, however, there is no assessment or credit for practical work.

Ireland currently produces a surplus of science teachers by two routes: the consecutive model (science degree plus a one year teacher training course) and the concurrent model (an integrated science with education degree). The majority of science teachers have Biology as their main subject. There is a major weakness in the lack of a systematic, career-long continuing professional development programme.

A unique feature of the Irish education system is the Transition Year Option (TYO), which is an optional year between the junior and senior cycles. This is offered by 75.4% of schools and taken by 50.7% of pupils in 2008/9.

Enrolment at third level in science and engineering courses is strong, and in 2009 intake into science courses increased by 25%. However, the brightest Science students still opt for professional courses and many of the students entering third level Science courses are quite weak. Ireland has one of the highest proportions of science graduates in Europe.

**Conclusion:** Science education in Ireland has many strengths and has been successful in a number of ways in the last decade, but there are also a number of systemic weaknesses in the Irish education system which have hindered progress. This paper will highlight some of the strengths and weaknesses and suggest some remedies.

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# The study of the linear elastic oscillator

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Keywords: oscillations, modern methods, energy.

This paper is meant to analyze the correlation between theory and didactic experiment in what concerns the phenomenon of real linear elastic oscillations. The experimental device used is the linear elastic pendulum.

The theoretical part is accompanied by classical and modern methods of experimental investigation. During the experiment the computer was used for image and film capture, and for the processing of measured experimental data. All this was obtained by using the Media Smart Webcam platform- program and Origin 7.0 graphics program.

In agreement with theory, the experimental graphic diagrams show a more pronounced decrease of the total energy of the real linear oscillator in comparison with the decrease of its amplitude as a function of the number of complete oscillations

The time evolution of the experimental parameters such as: the dynamic elastic constant of the elastic oscillator, the logarithmic decrement, the fractions of energy dissipated outside, the values of instantaneous speed and of the inertial forces present during the free elastic oscillations were measured during this experiment.

The measured parameters are in accordance with the theory in the field.

Through this interactive experiment students have the opportunity to understand the cyclic behavior but also the oscillating phenomena and natural systems.

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## The general picture of micro-world and our images of it

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In order to present phenomenon occurring at the microworld's level, we use several different models in process of education.

One of model types are graphic models which we divide into static and dynamic ones. Using static models causes creation of images in our minds different from those created while using dynamic models.

Many research show that student has his own images of it which we change during education. Frequent changes lead to the uprising of negative transfer which in spite of didactic actions often makes students stick to their own image students' image remains unchanged.

### Secondary school students' images of atoms and ions in the light of research

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With the help of a special computer programme, scientist have examined the way students imagine dependence between the atom and ion element. The students' task was to choose from the computer library elements such components that would illustrate the atom and ion and differences between them.

Students were divided in two groups. Students in first group were supposed to present their own image of atom and ion of lime and of the atom and ion of chlorine. However students of the second group were supposed to present their own images of atom and ion of sodium as well as of atom and ion of sulfur.

Researches' results were presented in the article.

# Forming of children natural science competences in integrated education

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Keywords: integrated education, natural science education, primary school, ecology

In a pre-school and primary school education an educational path created to develop natural science abilities and interests as far as pro-ecological attitudes was predicted. Generally it may be assumed that it plays two important roles: 1) preparing a child to further education in any field being a basis of modern biochemical, biomedical, agricultural and other technologies 2) providing a child with a knowledge and skills which would enable him to deal with any risk created by those technologies and protect his own environment against their negative impact. The importance of natural science and ecological education implies that it should be a subject of multi-aspect careful analysis with diagnosis aim, both on primary school and pre-school level. The subject of this paper are opinions of teachers concerning their realization of natural science and pro-ecological educational path. Over 100 people, including 48 pre-school teachers and 61 primary school teachers teaching in I-III forms and employed in podkarpackie district's schools were examined with the use of a questionnaire designed by the author. The investigations have been carried out in 2009. The data obtained permitted to state to which extent the teachers are able to perceive in some of their pupils particular capabilities and interests concerning natural environment and actions revealing a formation of pro-ecological attitudes among children. The second part of analysis concerns problems of teachers activities to develop students' knowledge and interests in natural science phenomena and processes in the course of educational process as far as forming of ecological responsibility. The importance given by teachers to natural science and pro-ecological education, the methods and means of didactical and educational work, understanding of a relation between shared knowledge and pro-ecological and pro-social attitudes were taken into consideration. On the basis of experimental analysis two kinds of conclusions were formulated:

1) conclusions concerning optimizing of natural science and ecological education effects in a pre-school and primary school education

2) conclusions concerning an improvement of natural science and ecological competences of teachers and future teachers by different forms of education for teaching staff.



# Biological, socio-cultural and educational correlates of first year non specialist course students' self-efficacy in the field of general chemistry selected problems' understanding

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Chemical knowledge plays a considerable role in students' education in numerous non-specialist courses like biology, environmental protection or agriculture. A graduate in those domains, even if in most cases will not deal with resolving of strictly chemical problems can often face chemical methods of quantitative and qualitative analysis and a competence in basic chemical concepts can surely help him to better understand the tasks performed during professional carrier as far as projecting them in a skillful way. One of key terms in this study is a self-efficacy which however is not defined as a general evaluation of one's image, but as an opinion about one's knowledge and abilities in a selected range of development opportunity [Bandura, 1986]. Thus a self-efficacy in chemistry is understood as an evaluation of one's capabilities to project and perform actions necessary to accomplish a given level of knowledge and practical skills in that domain. It may be supposed that inside chemistry itself there could be some problems creating difficulties even for people with a relatively high self-efficacy of their general chemical knowledge [Dalgety and Coll, 2006]. A low self-efficacy concerning those problems may influence students' learning efficiency. A prevention of that phenomenon may be supported by knowing of factors conditioning a low self-efficacy of students towards certain chemical problems which may enable to fit a program of teaching to the requirements of learners. It should be considered that early diagnosis of possible difficulties in chemistry studying permits to eliminate a memorial learning in favor of learning connected with associating facts and finding their logical explanation. The self-efficacy of students in particular problems seems very important for programming a university chemistry course because only in that way it is known which of them may cause real difficulties for learners as a consequence of perceiving them as hard to deal with. The students with low self-efficacy will not try to understand those problems even if they are potentially achievable for them. That is why a recognition of factors which influence a self-efficacy of non-specialist course students in the domain of particular concrete chemical problems included in the syllabus is necessary at the beginning of their university education. The investigation was carried out in the first semester of 2008/2009 academic year among a population of 63 students of Biology and Agriculture Faculty at Rzeszow University. It had a diagnostic aim and the examined groups were relatively small because it had been assumed that this kind of experiment required a simultaneous realization of didactic program being a subject of research. In the questionnaire students expressed their opinion on understanding of six chosen general chemistry problems learnt in secondary school and revised on first general chemistry class at the university. The problems were listed in six points: 1) Distinction between chemical reactions' types 2) PH of inorganic compounds' water solutions 3) Redox reactions' balance- an ability to fit the indices in redox reactions on basis of electron and mass balance 4) Electrochemical reactions 5) Solubility equilibrium and precipitates formation 6) Acid and base theories. Students could give three answers: "yes", "no" and "it is difficult to estimate" and a statistical importance of results was examined with  $\chi^2$  test. A subjective evaluation of basic chemistry knowledge among first year students of natural science courses: biology, environmental protection and agriculture varies from 23,8% of positive answers for "electrochemical reactions" to 84,1% of positive answers for "distinction between chemical reactions' types". Most of students do not report any problem with "pH of inorganic compounds' water solutions", "redox reactions' balance" and "acid-base theories" (60,3%, 63,5% and 55,6% respectively). Only 41,3% of students chose a



positive answer for “solubility equilibrium and precipitates’ formation”. The data suggests that at the very beginning of chemical education on natural science faculties the arguments causing relatively big difficulty may be selected to deal with special attention during the course. Among twelve investigated factors which may potentially affect a students’ self-efficacy in understanding of six problems listed above two: type of secondary school attended and period of chemistry learning in secondary school significantly influence students’ understanding of five out of six problems. Self-efficacy of four-years secondary (technical) schools graduates tends to be lower that for three-years secondary school graduates, while graduates who learnt chemistry at school for three years estimate their chemical knowledge higher than those who studied chemistry only for two years. Two other factors: types of studies and number of chemistry class hours per week in secondary school have a statistically important relationship with students’ understanding of three out of six problems. Self efficacy is higher for full-time students in comparison to part-time students and the bigger number of chemistry classes per week in a secondary school is, the higher self-efficacy grows. The investigations need undoubtedly a continuation on a bigger students’ group in order to confirm an influence of given factors on chemistry understanding self-efficacy. It would be also useful to compare students’ self-efficacy with objective tests’ results concerning analyzed arguments.

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## Pupils’ conceptions about the structure of solutions

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In our neighborhood there are no pure substances but mixtures. One of the types of mixtures are solutions. Pupils meet the solutions at everyday life and at the several stages of education at primary and secondary school, so that they have some information on the composition of mixtures. The research were carried out what do pupils think on the composition of mixtures which were prepared by dissolving different substances in organic and inorganic solvents. The paper shows the results of the research.



# Study on the quality of education at the Faculty of Chemistry, University of Gdańsk

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Keywords: quality of education, questionnaire study

In order to assure high standards of students' education, systematic studies on the quality of education as perceived by students are carried at the Faculty of Chemistry, University of Gdańsk [1,2,3]. The results are basis for the improvements recommended to the authorities of the Faculty. In the year 2009/10, a questionnaire study on the curriculum, content and organization aspects of education process was performed. The study was planned, run and concluded by a team of four faculty members, appointed by the Programme Council of the Faculty. The survey covered all obligatory and optional courses of two specialties: Medicinal Chemistry and Chemistry of Cosmetic. 76% students of the II year and 68% students of the III year (bachelor programme) took part in the study. They were asked a number of questions, concerning: organization of the course, punctuality of the classes, educational methods used by lecturers, content of the course, information about the evaluation and scoring marks, proportion of laboratory classes, lecturers' attitude towards students, lecturers' availability for consultations, and many others. Students could also include own comments. The results, in the form of descriptive research reports, were presented to the Faculty's authorities, to the Programme Council, and to the heads of chairs. The conclusions from the study will be used to introduce changes in the curricula and contents of the courses, to better planning in time, to achieve more uniform distribution of students' workload throughout the semesters, to increase diversity and attractiveness of the studying programme, and to eliminate observed deficiencies. They will also help to understand better the complex student-lecturer interaction in aiming for high standards of quality education at the Faculty.

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# System of maintaining and improving education quality at Chemistry Faculty of University of Gdańsk – survey

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Keywords: education quality, academic teaching, the quality of scholar education, surveys.

Gradually implemented system of quality assurance at the Chemistry Department, University of Gdansk is a tool for the analysis of processes related with teaching. The primary objective of this system is to systematically provide information about the progress of the faculty of education, both to the lecturers, and the authorities, which is a major goal of the University's mission in a competitive market of educational services, as far as academical education is concerned. An important element of quality assurance is an idea of surveys, which are aimed at students. The involvement of the student community shows that students are best-informed, go through the whole education circle, listening to the other students' opinions and, what is important, know the program disadvantages. Students want lectures to be both interesting and modern, and do not concern the interests of the Departments. This article presents the problems of research we carried out in form of anonymous surveys of student assessment of teaching competence of tutors in terms of content and organization. Collecting of opinions of students on the level of teaching, and teaching quality is extremely important for the interpretation of measurement, being an evaluation of the work for the university and has a direct relation with the shaping of university student's personality. Although the effects of our actions become visible in several years, owing to the common participation in the surveys, the participants of the study may now influence the shape of the Department in the future.

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# **Pedagogical and ecological educations of academic teachers as the basis for the forming of ecological consciousness of students**

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Keywords: ecological education, forming of ecological consciousness, educational process

An important role of educational work of academic teachers in formation of ecological consciousness of students is explained in the article. The main task of academic teachers is to provide the educational process. The preparation of teachers to training of innovation with a purpose realization of tasks of ecological education is also very important. That's why the development of different improvement forms of work in the sphere of pedagogical innovations for the teachers of higher educational establishments are required.

## **How to make students interested in nuclear physics?**

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Keywords: interest, nuclear physics, methods of teaching

Through teaching of nuclear physics we make our students feel that the growth of science has a real influence on the life of contemporary human being. Students have the opportunity to learn how the outcome of laboratory research is used in medicine, technology, food conservation and power industry.

In the thesis some teaching methods are presented that can increase students' engagement in the learning process and their knowledge of elements of nuclear physics.

Beside the traditional teaching methods some special solutions were proposed: excursions, educational games, students' projects and portfolio method.

The methods proposed guarantee large diversity giving a teacher a wide choice depending on the level of the class and on school reality.

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# Learning styles of their students' achievement and scientific process skills and attitudes on the impact

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Keywords: Learning Style, Attitude, Achievement, Scientific Process Skills

The role of the learning styles of the learner is important to be considered in their impact on learning. Individual learning styles differ, and these individual differences become even more important in the area of education.

The purpose of this study is to determine the effects of learning styles on the student achievement, scientific process skills and attitudes toward chemistry and laboratory. The Grasha learning styles scale was administered at the beginning at the semester students works as a group based on different learning styles.

Study consisted of sixty pre-service science teachers; to find out student learning styles and organized laboratory groups; in order to evaluate student achievement, scientific process skills and attitudes toward chemistry and laboratory, Kruskal Walliss test and Mann Whitney U test were used.

Moreover, achievement, scientific process skills and attitudes toward chemistry and laboratory were also administered at the beginning at the semester as a pre-test and at the end of the semester as post-test. The results indicated that there is a significant difference between pre and post-test concerning student achievement on general chemistry laboratory and scientific process skills. There is no significant difference was not found between pre and post- test concerning attitudes toward chemistry and chemistry laboratory.



# Research on the new methodologies and tools for teaching the subject “Lipids” in upper secondary school

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Keywords: lipids, methodologies projects, educational tools, motivation, interdisciplinary topics

The purpose of this project was to prepare a range of methodologies and educational tools that would be useful for teaching the subject “lipids” at upper secondary school. The most important goal was to get students curiosity, commitment, and motivation. In my research work I have been extending a study of problem of teaching chemistry in non-science specialist’s class. The project is addressed to students of non-science specialists class, in particularly (Florek, 2007, 2008), as well is designed to encompass their non-chemistry interests and passions. The main educational goal is to encourage a form of teaching which would enable students to understand some problems connected with everyday life. An emphasis is given to achieve an increasing student’s motivation in finding scientific solutions (Galloway, 1998). The priority was to find the way to get students attention on the subject (for example the method of the initial inspiration was provided).

Sets of teaching strategy of the chemistry lessons and educational tools for students have been prepared. The projects have been designed to be easy in using by school classes.

The project has been tested on the groups of students from Gdansk’s schools during preliminary school lesson and laboratory activities. The effectiveness of the project was evaluated using a range of techniques.

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# The development and validation of scientific inquiry abilities test

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Keywords: argument and contradiction, competition theory, scientific inquiry, science process skills

Science as inquiry is basic to science education (National Research Council, NRC, 1996). In the last few years, several articles have been devoted to the study of scientific inquiry (Fradd & Lee, 1999; Hinrichsen & Jarrett, 1999; Sandoval & Reiser, 2004; Schwarz, 2009; Ruiz-Primo & Furtak, 2007). An appropriate instrument for educators to measure related constructs is imperative. Based on the related theories, the purpose of this study was to develop a reliable and valid Scientific Inquiry Abilities Test (SIAT) for practical and academic uses. Two hundred and thirty 10th, 11th, and 12th graders in Taiwan participated for item analysis and construct validity test. The results were as follows: (1) The SIAT contains 27 items including 5 testlets. The score of 'Recognize pattern' testlet including 2 items was 12; the score of 'Science process skills' testlet including 9 items was 9; the score of 'Inquiry and Argument' testlet including 5 items was 8; the score of 'Competition theory and Evidence' testlet including 6 items was 18; the score of 'Argument and contradiction for competition theory' testlet including 5 items was 11; (2) There were low correlations existed between each two Testlets scores ( $p < .000$ ), the values were from .158 to .323; (3) There were moderate correlations existed between all testlets scores and whole test scores ( $p < .000$ ), the values were from .534 to .684; (4) The internal consistency was .629, and the scorer reliability coefficient was .964; (5) There were 70 students selected as high achievement and 67 students as low achievement on the basis of the SIAT. High achievement students outperformed their counterparts on SIAT and all testlets with large effect sizes. These results indicated that SIAT has quality reliability and construct validity. Finally, implications for future research and science teaching were discussed.

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# Effects of the training course for students “Sustainable Development Educator”

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Students of biology, specializing in teaching biology and geography and teaching biology and chemistry participated in 45-hour course “Sustainable development educator.”

The purpose of the training course was to gain knowledge and competence in organisation and implementation of education for sustainable development in- and off-

The course was modular in nature. The contents have been grouped into five training modules:

1. Sustainable development in the environmental aspects;
2. Sustainable development in economic aspect;
3. Sustainable development in the social aspect;
4. Methodology of education for sustainable development;
5. How to obtain funds for education for sustainable development.

Effects of the training course were measured by diagnostic test. The results will be presented in the article.

## The Development of Teacher Competencies of Future Chemistry Teachers by means of Micro-educative Analysis

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The aim of this contribution is to inform about pre-graduate teachers preparation according to valid School Act No. 545/2008 Coll. dated on 22nd of May 2008 about education in the Slovak Republic. According to this Act, the stress is put on obtaining key competences of pupils as a product of complex education and self-education.



For the fulfilment of this task we have been training future (pre-service) teachers of chemistry within a grant project APVV 0088-07 „Micro-educative analysis in pre-gradual teachers' preparation of the science subjects as a tool of increasing of competency education effectiveness“, a grant project VEGA 1/0193/08 and KEGA 3/6301/08, through micro-educative analysis as a tool of increasing quality of obtaining teachers didactic skills.

Pre-gradual preparation of students through a microteaching and microteaching analysis is done within the subjects as the General didactics and Subject didactics.

Under the term of microteaching we understand training teaching competences of pre-service teachers by short lessons (sessions) and later on evaluated their outputs by participated students and teacher. During microteaching a student short lesson is videotaped. The aim of this way orientated training of pre-gradual teacher is to point on strengths and also weaknesses of each student in the position of a future teacher. This training model gives student real, non-distorted view on them as a future teacher. This view is important for their self-assessment and self-education. In microteaching we concentrate on the fact, that students should acquire activate methods of teaching process together with usage of informative-communication technologies and present contents, which are included in State Education Programme. To these days the didactic materials such as food, healings, washing liquids and cosmetic chemistry have not been prepared for pre-gradual teachers yet.

Through microteaching is emphasised formation and development of teacher competences such as psychodidactic competences, subject specific competences, communicative competences, organisational and managerial competences, diagnostic and intervention competences, competencies in professional reflexion focused on evaluation of own pedagogical action, modification of own behaviour in a classroom.

Obtained teaching competences area applied by students on their continuous teaching practise directly in real school conditions.

The aim of research in projects is to contribute with microteaching and micro-educative analysis to the effectiveness of pre-gradual preparation of science subject teachers.

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# Student Characteristics and Success of Implementation of a Student-Centered Approach on Selected Chemistry Topics

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Keywords: Student characteristics, student-centered approach

In an effort to make science learning more interesting and worthwhile, researchers and educators all over the world continue to develop new teaching strategies. During the past decades, the largest educational evolution is the transformation of classrooms from being teacher-centered to one that is student-centered. Compared to the conventional teacher-centered teaching approach, the student-centered teaching approach (SCTA) allows learners to have better retention, better transfer of knowledge to other situations, better motivation for further learning, and better problem-solving abilities (Mckeachi, as cited in National Research Council, 1997). However, the implementation of the SCTA remains as a challenge to most teachers, and lecture-discussion is the dominant teaching method used in science classrooms (Tibajares, 2001).

In other countries, several studies have identified a number of factors contributing to the difficulty of implementing student-centered teaching approaches. These factors can be classified into four categories: 1) teacher-related, 2) school-related, 3) curriculum-related, and 4) student-related factors (Afshari, Abu Bakar, Su Luan, Abu Samah, & Say Fooi, 2009; Felder & Brent, 1996; Grabowski, McCarthy, & Koszalka, 1998). However, most of the researches done focused on the first three factors. Particularly, the pedagogical content knowledge of teachers and the effects of availability of school facilities on teaching and learning were the focus of the aforementioned studies. This is why it is suggested that student-related factors should be explored.

This study aimed to determine the effect of student characteristics on the success of the implementation of student-centered teaching approach on selected chemistry topics. Specifically, the study sought to identify any significant difference in students' behavior in class, ability to answer open-ended questions, ability to work in teams, and responsibility regarding assignments between students from a higher section and those from a lower section. This problem was formulated based on the assumption that the SCTA will be successfully implemented to a group of students with more positive student characteristics.

The Student Characteristics Observation Checklist (SCOC) sought to identify any differences in student characteristics between students exposed to the higher level student-centered teaching approach (HSCTA) and those exposed to the lower level student-centered teaching approach (LSCTA). It was developed by the researchers to take note of the students' reactions toward the SCTA during its implementation. There are 20 items on this checklist and spaces are provided for additional remarks to be filled by the observer to allow qualitative treatment of data.

The results showed that students from the higher sections possess more positive student characteristics than those in the lower sections. Specifically, students from the higher level student-centered teaching approach (HSCTA) group exhibited a highly positive behavior in class, while both groups showed difficulty in answering open-ended questions.

Within the HSCTA group, only the ability to answer open-ended questions came out negative while the students' behavior in class appeared to be highly positive. On the other hand, the characteristics of the LSCTA group turned out to be negative with their ability to answer open-ended questions and ability to work in teams highly negative. Table 1 presents the mean SCOC

ratings of the HSCTA and LSCTA groups.

Table 1. Mean SCOC Ratings of Students in the HSCTA and LSCTA Groups

	HSCTA		LSCTA	
	Mean Rating	Assessment	Mean Rating	Assessment
Behavior in class	2.61	Highly positive	1.33	Negative
Ability to answer open-ended questions	1.20	Negative	0.47	Highly negative
Ability to work in teams	1.81	Positive	0.62	Highly negative
Responsibility regarding assignments	2.01	Positive	1.22	Negative

Rating: Highly negative: 0 – 0.75; Negative: 0.76 – 1.50; Positive: 1.51- 2.25; Highly positive: 2.26 - 3

Possible reasons for the differences in behavior in class between the two groups may be attributed to schedule of chemistry class, personality of teacher, and seating arrangement. Difference in ability to answer open-ended questions may be due to the level of communication skills, unfamiliarity to open-ended questions and to SCTA, and lack of confidence because of anticipated reactions from classmates. On ability to work in teams, difference may be attributed to frequency of group activities given, students' attitude toward group tasks, group size, and seating arrangement. Finally, other responsibilities of students at home may be the reason for the difference in students' responsibility regarding assignments.

For the particular aspect of the study presented in this article, the following conclusion was drawn: Students from the higher section have more positive student characteristics in terms of behavior in class, ability to answer open-ended questions, ability to work in teams, and responsibility regarding assignments.

The results of this study suggest that most students have difficulty in answering open-ended questions. Since the ability of students to answer open-ended questions is important in the implementation of student-centered teaching strategies, the use of open-ended questions in class discussion and in assessment is encouraged. Moreover, this practice enhances critical thinking and communication skills of students.

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# The attitudes of 15-year-old Latvian, Polish and Czech students towards science topics

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Keywords: comparative studies, science teaching and learning, ROSE project

The aim of the study was to look at the interest of 15-year-old students from three countries (Latvia, Poland and the Czech Republic) in selected topics in biology, chemistry and physics, and to determine if it had changed over a five-year period. The analysis was based on the results of an international comparative research project “The Relevance of Science Education” ROSE (Schreiner, Sjøberg, 2004) from 2003 (LV: 1065; PL: 654; CZ: 2005 students) and of additional studies carried out in 2008. (LV: 746; PL: 156; CZ: 141 students).

The respondents were divided into typological groups. It was found that the number of students who had a negative attitude towards science had increased from 49% to 55% in Latvia, from 54% to 57% in the Czech Republic and from 46% to 59%, that is the most considerably, in Poland. The percentage of students who had a positive attitude towards science had dropped slightly.

The mean values ( $1 \leq M \leq 4$ ) for students' interest in particular science topics had decreased in all three countries, except for chemistry in Latvia and the Czech Republic. However, the level of interest in chemistry was as low as 2.5, which meant that most of the students surveyed were not interested in chemistry topics. It was demonstrated that there was no significant statistical difference between students' interest in science topics found in the studies from 2008 and 2003, with the exception of the interest in biology in Poland ( $t = 2,855$ ;  $p = 0,004$ ,  $\alpha = 0,95$ ).

Students' interest in chemistry topics in all three countries did not change in the time between the two studies. Students would still most like to learn about poisonous plants and explosive chemicals. As far as physics is concerned, the most popular topics were those related to the universe and to technology. As for biology, the topics the students found the most interesting were those related to health, and Latvian students were the most eager to study them. The topics which the students from all three countries were the least interested in were the following: atoms and molecules, conversion of crude oil into other products, symmetries and patterns in leaves and flowers, plant growth and how engines work.

The results obtained in the study may be used by teachers as a basis for modifying their methods of teaching science subjects.

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## **“Eco-signs on stage” – excursion**

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An adequate and effective environmental protection depends on the level of public awareness and the preferred lifestyle. Today, great importance is attached to the development of environmental awareness of students at every level of education. The use of different work forms with a child, pupil, student, allows this awareness to form, for example, through fun a child is having when attending a kindergarten. Children at this age learn best through exploring and experiencing the world. Classes are based on the transmission of knowledge by engaging their senses and imagination, the use of multiple talents and natural curiosity. The planned group work, stimulates their creativity, ability to combine facts, as well as develops the ability to lead a discussion (key skills).

The presented draft schedule “with a camera among the eco-label” in the form of an excursion is designed for children in age of 6-12 in order to transfer the knowledge about eco-signs and to develop environmentally friendly behavior. This outline continues the series of educational activities, of which a part - for junior high schools and secondary schools - was presented last year at a conference in Hradec Kralove.

To check the pupils’ knowledge about ecology a questionnaire has been prepared. The results will be presented and discussed on the poster.

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# Place and role of multimedia didactic means in the Program of Building Key Competences for Junior High Schools

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keywords: chemistry, curricular basis, key competences, distant teaching, multimedia, animations

In the curricular basis which was introduced in Poland in 2009 the term "key competences" is nowhere to be found, however, having read the document carefully the reader is convinced that such competences need to be developed. The document reads, "The most important skills acquired by students on the third and fourth stages of general education involve reading, mathematical thinking, scientific thinking, the ability to communicate in their mother tongue as well as in foreign languages, the ability to efficiently use modern information and communication technologies, the ability to search for, select and analyze information, the ability to recognize students' own educational needs with respect to learning and, last but not least, the ability to work in a team." This points to the fact that when implementing the curricular basis in junior high schools, all these key competences need to be developed as well.

The tasks within the e-Academy of the Future project include teaching Science in high schools which aims at developing seven key competences: 1. mother tongue communication, 2. communication in foreign languages, 3. mathematics and basic scientific and technological competences 4. information technology competences, learning skills, 5. social and civil competences, 5. initiative and entrepreneurial skills.

Their participation in the project will definitely make it possible for the students to develop all these skills during their typical school-related work as well as whilst doing their project work and covering their e-learning units. The resources of the units will contain various multimedia presentations, including 3D techniques. It is assumed that the presentations will not only improve the level of understanding of the tasks specified in junior high school Chemistry curricular basis or the quality of skills which prepare the students for independent laboratory and environmental research but they will also improve their active participation in tasks at hand and, what is more, they will involve those students who reveal some learning deficiencies.

Furthermore, it is also assumed that the implementation of blended learning classes will prove to be extremely profitable not only for the school, but for the teachers and students as well.

It is also believed that junior high school graduates who have participated in the e-Academy of the Future project will be familiar with their learning preferences and, at the same time, they will be able to adjust their own learning strategies to their psychological and physical preferences.

# The attitude of medical students towards the use of modern practices determines their future professional performance

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Keywords: attitude to learning, professional competences, medical students, medical education

In changing times, efforts must be made towards the development of universities, not only as universities, but also as independent scientific and research centers. The aim should be to establish them as centers of excellence in training so that they can determine their own mission, which includes the practical training of students with the most modern achievements in science and especially medicine. Our research on attitudes and motives of medical students for learning showed that students' cognitive activities are extremely sensitive to the effects of new scientific discoveries in the field of medicine and their subsequent application in practice. Student motivation for learning modern practices and their use in their future professional activity is far higher than the absorption of the classic fundamental knowledge included in academic curricula. The formation of professional competence of students, based on the utilization of modern training practices, ensures that they contribute effectively in the coming decades, when they serve in different organizations/hospitals. In the context of medical students, the attitude of students assumes immense importance as it significantly modulates their future professional activity. Considering this, attention should be focused on developing the right attitudes in the medical students.

## Science Education in Canadian School System

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Keywords: science processing skills, big ideas, PISA, scientific literacy

The report gives information about the Canadian School System and the success it has achieved according to the international standards set by PISA and TIMSS. For this reason, the concepts and methods employed in science education in Canada deserve attention. Many Central European countries are seeking new resources for the reformation of their science education programs, which have not in the past led to a sufficient level of competency among students of science subjects, nor have they been very reliable and instructive for the teachers. On the other hand, breaking down “big ideas” in the science curriculum into specific processing skills in the science textbooks appears to be essential in achieving good results in developing scientific literacy.

## Subject „Radiation Protection“ in environmental study programmes

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Keywords: ionizing radiation, radiation protection

The natural radioactivity is an inseparable ingredient of environment. Mankind during its evolution was permanently exposed to an influence of radioactive radiation. Nowadays besides the natural radioactivity, we meet the applications of ionizing radiation practically everywhere. In all complex matters there the specific changes occur as a consequence of radiation. Also many biochemical reactions in human organism occur in a different way under an influence of radiation. So the study of the relation between radioactivity and human being, or between radioactivity and environment has received great attention in recent years.

These facts were the main reason for an implementation of new subject “Radiation Protection” into the engineering study in study programmes Environmental Chemistry and Technology as well as in Chemical Engineering, at Faculty of Chemical and Food Technology in Bratislava last year.

Understanding of philosophy of radiation protection assumes a perfect knowledge of physical principles of an origin of various types of ionizing radiation, knowledge of interaction processes of ionizing radiation with the matter. It is necessary to acquaint students with the basic detection methods too.

The principles of radiation protection work on the knowledge of chemical and biochemical influences of ionizing radiation on human being. Also the technical and organizing questions of radiation protection are very important including the legislation.

For successful managing of such wide-spectrum subject we prepare the textbook that contains the text part and DVD part with the image attachment and short video-films of our production.

The contribution will summarise our experiences from the teaching-learning process of this subject at Faculty of Chemical and Food Technology, as well as at Faculty of Mathematics, Physics and Informatics. We shall also focus on versatile usage of this educational product –textbook with videos. It can be used not only in pedagogical process at our faculties, but also on high schools and colleges, but also it can serve as information or promotion material for general public.



# **Ionizing Radiation, its Effects and Protection against it**

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Keywords: ionizing radiation, radiation protection, video-films

Ionizing radiation is nowadays applied in many branches, from science, to various industrial sectors and nuclear power-plant engineering. Last, but not least is its application in medicine. Besides many positive properties, ionizing radiation can have also a negative influence on health and environment. Therefore it is needed to follow the rules of radiation protection at the work with the ionizing radiation.

In our contribution we want to familiarize the readership with the content of our multimedia part of the textbook “Radiation Protection”. It deals with the set of video-films about radioactivity, about the usage of ionizing radiation in research and medicine, as well as videos from the field of radiation protection.

The video-films can be used as an educational product at various types of schools in many subjects related to ionizing radiation, radiation protection, radioecology, radio-pharmacy, biomedicine chemistry and physics.

In conclusion we can emphasize that the use of the video-films in teaching-learning process generally, leads to the improvement of its quality.



# Students' Attitudes and Considerations of Archimedes Law - Use of Historic Introduction in Science Teaching

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Keywords: the role of the philosophy of science education, History of science, Methods in teaching science.

One of the most significant methods in science is the formulation of the appropriate hypotheses and its testing. This particular part of science requires the researcher to use imagination, creativity and skills in order to formulate a hypothesis that is new, funny sometimes and strange at other times. Such hypotheses may be reached as a result of a dream, intuition or accident. The findings of the study clearly show that students changed their viewpoint of Archimedes after their knowledge of the story of his discovery. They thought that everyone who works in science possesses the ability to discover what Archimedes has discovered. This emphasizes the significance of scientific imagination and intuition for scientific discoveries, which should be used through the historic introduction in science teaching.

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## Teaching children to value solar energy

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Key words: Environmental Education, Science and Technology Education, Solar Village, Educational Initiat

In this educational initiative, we suggest to build a real model of solar village inside the school, which uses only solar energy. These educational initiatives emphasize the importance of energy for a technological society and the advantage of alternative energy sources. In this scientific educational initiative, the pupils in three elementary schools in Israel were active participants in building systems that use solar energy to work.

The study objective is to examine the educational, social and scientific impact of the initiative on students, parents and teachers and their readiness to support and participate in such educational initiative.

The study results showed that the three groups highly appreciate the project educationally and socially. They feel that the execution of the initiative inside the school promotes creativity and thinking ability among students.

Parents showed a great support for the project, because they see the positive impact of the project on their children's learning ability.

Teachers considered this initiative quite important due to the students' interaction and interests, which leads to the success of the school. It also improves the learning skills of the students such as reading plans, executing research and writing reports.

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## **Electrolysis of water using accessible materials: a case study of its implementation with middle and high school teachers**

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Keywords: Electrolysis, micro-scale, case study, chemical education, survey

In this project we present simple and feasible ideas to introduce the implementation of microscale electrolysis experiments using accessible materials in the classroom. The students observed the change at the anode and the cathode by using disposable materials.

When we introduce these activities to the teachers in the elementary, middle and high school and we asked them to express what are the main reasons that motivate them to implement this activities in their classroom, the participants stated in general that: This activity is very simple, the experiments can be carried out quickly, even at home or outdoor; the students will be engaged and will feel part of the discovery process Their creativity will definitively be simulated.

The teachers believe that these activities will enhance the learning process in their classroom, claiming that today most of their students are visual learners and this kind of activity would motivate and engage them in a learning process of these concepts.

Using the microscale experiment with disposable materials in the electrolysis process allows the students to visualize what happens during electrolysis. Although, they believe that using disposable materials make the experiment simpler, so they can think about other materials that they can use and if they don't have, they will find the way to obtain them or providing alternative materials that are easier for them to obtain.

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# Homework in Chemistry Teaching

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Homework is an integral part of education. This is the form of obligatory or additional school activities. Their aim is to broaden, intensify and consolidate pupils' knowledge as well as to inculcate self-dependence in using it, collecting information, solving problems and written elaboration. Thus it is an indispensable link in teaching-learning chemistry.

Literature dealing with studies does not devote much attention to this problem. There are no analyses of its application goals, function and role it should perform in contemporary education. Unfortunately, it is a neglected element in science education. Properly planned, organized and applied homework would balance effective and modern education and effective and conscious learning. It seems necessary to reconsider views about role which can and should be played by homework in the educational process.

To diagnose and understand difficulties which teachers and pupils come across in the way of using and utilizing homework in the school year 2006/2007, the survey was carried out in six junior secondary school in three Polish cities. This aimed at collecting opinions of pupils and their teachers about using homework in the chemistry teaching and learning processes. The obtained results are as follows.

In pupils' opinion frequency of giving homework is too low. Difficulties connected with its realization are scare. If they occur, pupils can always count on teachers' assistance. The difficulties pupils come across doing their assignments most frequently result from the lack of understanding the task or material to be applied in connection with it. Consolidation of knowledge or acquisition of new knowledge are the most frequent functions of homework.

Pupils are not often aware of the aims connected with homework. Task contents are not very attractive and estimated as boring or worthless by pupils. Their subject matter is rarely connected with practical knowledge useful in everyday life. Activities associated with doing tasks are tedious often causing weariness. Despite these above mentioned drawbacks of homework, pupils say it should be given. Among the proposals of kind of homework are: experiments, paper, notes, models, presentation, posters, crossword puzzles and chemical reaction equations.

In teachers' opinion homework accomplishes the training and cognitive functions which results from a too small number of chemistry lessons designed for realization of chemistry contents. Thus there is not enough time for training and revision during the lessons. The most frequent forms of homework are calculations training tasks and various forms of preparation for the lessons. Checking homework is done in two ways: either an individual pupil presents the results or the whole class discusses the solution if individual tasks,. Frequency of checking homework is not satisfactory. Teachers give it up and move to discussing a new lesson content. In the case of difficulties connected solving assigned tasks, they give detailed tips how to do them. Teachers are aware of the drawbacks in this aspect.

The obtained data inform about the way and form of homework in Polish schools and show the difficulties pupils and teachers come across. As follows from the survey homework is not comprehensively used in chemical education. It does not accomplish all educational functions which could make it an attractive, effective and independent activity of learners. More detailed and profound analysis of function and role of homework in chemical education should be carried out.

# Multimedia presentation „useful chemistry” as a form of chemical knowledge popularization

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Keywords: chemical knowledge in everyday life, multimedia presentation

Chemical education of youngsters decides largely about chemical education of the society. It manifests itself in the proper use of chemical industry products not imposing threat for people and the environment. As follows from the studies carried out for many years, pupils are not interested in learning science [1,2]. Some attempts should be undertaken to change their negative attitude. A simple way to arouse interest in chemistry is showing applicability of chemical knowledge in everyday life. Teaching chemistry, relating it closely to everyday life, allows pupils to see that the knowledge acquired during chemistry lessons can be useful for understanding and explaining problems occurring in their closest surrounding. This conviction about usefulness of chemical knowledge can promote pupils' motivation for learning this subject and choosing it as the subject of university studies [3].

The question arises how to change pupils' attitude towards chemistry and arouse interest in it. Besides effective school education, the emphasis should be made on extra school education. To meet this idea, higher education institutions undertake various activities for the school environment. Some cyclic events like “open door” and science festival have been organized for a few years, in order to popularize education. They include lectured, demonstrations, presentations, discussions, displays and workshops in various fields of science among, others, physics, chemistry, biology, agriculture, technique, history, psychology, culture and art.

Within the science festival and open door events the staff of the Department of Chemical Education, Faculty of Chemistry have been organizing meetings about applicability of chemical knowledge in everyday life for junior and senior secondary school pupils [4].

In the school year 2008/2009 there was made, among others, the multimedia presentation including simulation, animation and short films about washing, laundry and cleaning. This event was broadened with presentation of interesting experiments giving the answers to the following questions: how to remove dirt, what is better for washing: gel or soap, what reaction good cosmetics should have, how ACE and Vanish act, ect...

Both teachers and pupils take an active part in the above mentioned events and express the need for continuation of this type of education.

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## **Research on pupils' ideas on the structure of hydrocarbons using a computer program**

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Hydrocarbons are one of the simple groups of chemical compounds since they are composed of two elements carbon and hydrogen. In the process of education students use mainly structural models. But it is very important to know how students imagine of different hydrocarbon molecules.

A computer program was constructed and used in order to test what image of the structure of hydrocarbons have pupils in Polish secondary school. This work shows the results of the research.

## **Increasing the activity of students during laboratory classes of Didactics of Chemistry**

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Keywords: experimentation, pre- service teacher training

Currently, teachers have to develop in their pupils both the skills related strictly to the subject taught and versatile skills useful in life (so-called key competencies). However, the teacher, who himself does not have these skills, will not be able to educate them on their students. Therefore, it is important to include in pre-service teacher training, training of key competencies. This training should be mandatory for all classes in which students gain professional qualifications.

At the laboratory classes of Didactics of Chemistry at Faculty of Chemistry of Gdansk University there was changed the formula of classes so as to increase the activity of students, future teachers of chemistry and to prepare them better than ever before to work in a Polish school. These changes have produced visible positive results. Previously, on the laboratory classes of Didactics of Chemistry, to the academic year 2006/2007, students conducted school experiments in accordance with the instructions contained in the script or prepared by the academic teacher. Since the academic year 2007/2008 on these classes, students had to prepare their own collections of chemistry experiments to a given group of subjects. They had to look for the instructions for



these experiments in school textbooks, in books of chemistry experiments, in the internet or create by themselves. At the laboratory classes, students carried out experiments, and modified if necessary their instructions. To allow students to get to know the pupils, with whom will work in the future, students had to organise two workshops in laboratory designed for pupils. In these classes, pupils conducted simple chemical experiments under the supervision of students. Students were responsible for these workshops, they prepared a place of work, instructions, and supervised the work of pupils and conducted their observation.

This laboratory classes of Didactics of Chemistry increased students' skills in the field of experimental activity: the students improved their skills in work planning, in conclusions drawing, in dealing with problems. Students' direct contact with the pupils influenced upon a better understanding of pupils, their interests and capabilities, and increased sense of responsibility for students' work.

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## **Promoting sustainable and healthy attitudes among pupils – thesis papers of undergraduate bachelor students**

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Keywords: environmental education, health education

In the academic year 2008/2009 in the Department of Didactics of Chemistry, Faculty of Chemistry, University of Gdansk a number of students prepared projects as part of their bachelor thesis papers that were intended to be realized among pupils. As a result of thesis papers of third year students of chemistry with computer science as their specialization, four projects were prepared in the area of pro-ecology and pro-health, with the following titles: “The addictive substances are your enemy”, “Another view at food”, “Stop the waste, or what to do in order to harm the environment less” and “Change of environmental behaviour among youth.” With these projects, the first was addressed to high school students, while the other three were addressed to middle school students. In each of the projects students from different schools were involved. Three projects were conducted at the Department of Chemistry, while one regarding pro-ecological behaviour due to its specifics was conducted with students in their schools. Projects were planned to carry out lessons or a series of meetings which purpose was to acquaint students with the broad theme of the project and generate a positive change in their behaviour and thinking on the topic presented. During classes held at the Department of Chemistry, students conducting the lessons used a computer, a multimedia projector and a multimedia board, which positively influenced the involvement of youth in the course of the class. Pupils participating in the projects always actively participated in class and showed interest in the lesson's subject. Chemistry students for their part, tried to present a fair view of the existing situation, visualize the specific problem, interest the youth, and stimulate their thinking. Students quoted relevant facts and figures, creating in pupils a variety of feelings, which gave them a chance that the achieved effects will last longer.

The authors of the projects also developed instructional materials necessary to carry out proposed activities during classes (small compendium of essential knowledge on a given subject, sample outlines of classes, descriptions of possible experiments, tasks and games including relevant cards to those tasks and games). These materials were submitted for the opinion of several chemistry teachers, guardians of pupils participating in activities. Submitted materials have been evaluated well and in teachers' opinions constituted an appropriate basis for carrying out activities for the designated topics.

Proposed by the chemistry students, as part of their bachelor thesis papers, classes were very well evaluated by both the pupils and their teachers, and gave satisfaction to the authors. This kind of bachelor thesis papers that have a practical dimension is particularly recommended for students who like to have contact with other people and feel the need to teach others.

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## **New approach to school organic experiments in small scale chemistry technique**

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Small-Scale Chemistry is an experimental technique using non-traditional equipment and working with small quantities of chemicals. It offers many benefits for teachers and pupils. First of all is more safety, more economic and considerable reduces amount of waste. It is widely used for teaching chemistry at different levels in many countries. The paper relates some new approaches to school organic experiments in SSC technique which widen the experimental pupils' lab work.



# Development of critical thinking for medical students in chemistry course

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Keywords: critical thinking, study process, reflection, didactic methods.

Higher education must adequately respond to new conditions and it must provide appropriate potentialities. The goal of education is not to obtain qualification and certain skills for whole life any more since nowadays it is often necessary to change orientation of professional activity or to combine several fields of operation. Modern society needs future oriented pedagogy – system of intellectual and psychological development which motivates future specialists to master every new technology in order to receive financial benefit as well as psychological satisfaction.

All of the above mentioned is expected from medical students while placing emphasis on high level of responsibility, professionalism and tendency for improvement. A continuous flow of information puts medical students in front of a choice between already known and new. It is therefore necessary to think elastically and to be ready to verify information and admit mistakes – it is necessary to be able to think critically. The main characteristic of such style of thinking as an intellectual system is ability to analyze all problems, to form systematic bonds, to distinguish contradictions and their solutions as well as to anticipate possible variants of solutions for given problems since intellectual development is not possible without reflection and critical thinking during process of problem solving.

While studying chemistry, students have an opportunity to use critical thinking methods for certain purposes – investigation of laws of nature. Development of critical thinking therefore is an integral component rather than the goal of medical education. Education method is based on development of critical thinking during practical work, development of study process organization skills, critical analysis of information, situation modelling, self-assessment and self-dependence. As research shows, the most effective didactic methods are:

- Special assignments where students have to verify given facts and determine their precision, errors or discrepancy;
- Situations where students are directed towards intensified analysis of conditions of assignment;
- Lecture materials with incorporated logic based examples which emphasize the unproductiveness of unambiguous assessments;
- Textbooks with information regarding development of laws and theories of science and attitude towards once denied ideas throughout the history;
- Mastering of science based research principles which include promotion of theories, repeated practical testing and statistic processing, result analysis and conclusion drawing.

# Research results of achievements in general chemistry by the first year students

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Keywords: achievements of students in general chemistry

**Introduction:** There has observed for a few years that the school leavers of lower and lower chemical knowledge undertake to study chemistry at university. Their achievements are not satisfactory after the first semester of studies [1]. Therefore some questions arise:

– What chemical knowledge and skills do secondary school leavers possess when they start to study chemistry at university?

– Which chemical problems are the most difficult for them?

**Research:** The replies to the above questions are provided by the research which has been carried out since 2005. The research tools used are the tests including questions in general chemistry mainly based on secondary school education. The research is carried out at the beginning and the end of the first semester that is before the beginning and the end of the general chemistry course. The results of the tests are compared with those achieved from the secondary school final exam.

## Conclusions:

1. Comparing the average results of the research carried out at the beginning and the end of the first semester, it can be seen that pupils have poor achievements in general chemical knowledge and skills acquired at secondary school and the progress is small after the first semester [2].

2. The lack of knowledge growth is related to two groups of tasks. The first one includes the tasks which were solved both before beginning and after finishing the general chemistry course. This can indicate that pupils acquired good knowledge of these problems at secondary school and it is still on a good level (e.g. electron structure and position of the element in the periodic table). The second group includes the tasks which received low percentage of correct replies in both dates of research. This, in turn, can indicate that the problems presented by the tasks were not mastered at secondary school and pupils still find them difficult (e.g. types of bonds, equilibrium constant of chemical reaction) [3].

The research carried in 2005-2007 and its results were presented during the Faculty Conference in 2007. However, the general chemistry teachers are informed about the research results every time they are carried out. Some attempts are made to raise the standard of general chemistry classes; among others, some changes are made in the lecture program, forms of classes are changed, more time is devoted to practical aspects of elaborating the problems which are difficult for students.

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# The role of experiments in chemistry teaching to students with special educational needs

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Nowadays, the number of students with various dysfunctions is still increasing. Among them, there are children with mild mental retardation. There is a variety of disturbances in mental processes in this group of students, mainly related to the problems with concentration, perception and understanding abstract concepts. Therefore, in teaching children with special educational needs, it is important to select methods which allow them to have a better start in the world of people without disabilities.

One of the subjects, requiring special selection of teaching methods, is chemistry. This subject leads students into the great world of chemicals, which are present in their lives. The aim of this research is to determine how the chemical experiments influence the perception and learning processes of the concepts connected with acids.

## Study of generation differences of science concepts outside a science community

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Keywords: concept, misconception, the grounded theory method.

The presented paper studies and compares the level of understanding of selected science concepts and their application to the everyday life of students and the non-scientifically

oriented population. Our research took place in Slovakia. The concepts studied cover the topics of particle theory, dissolving and genetic modification.

- The discovery of how certain phenomena are interpreted is an important factor in the attempt to improve scientific literacy during and after formal schooling. We hoped to answer the question of the long-term effect of scientific knowledge on the life of adults and on lifelong education.

- The data were obtained by semi-structured interviews and were analyzed by the grounded theory method.

- Qualitative analysis showed a noticeable discrepancy between the concepts included in the school curricula and the participants' personal interpretation of the material. The adults lacked relevant scientific concepts. Technical terms used by the participants were misleading as they didn't necessarily correspond with meanings accepted by the scientific community.

- The collected and analyzed material is a contribution to the broader discussion about the quality and meaningfulness of formal schooling and its reflection in the social and personal life of a society.

# Hospitality Managers' Service Competence

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Keywords: Service competency structure, Hospitality manager.

**Purpose:** The article reflects a research about defining the concepts of competence and offers a structure of hospitality managers' competence developed by the author.

**Methods:** The author performed a research of the scientific literature, which views the definition problems of the concept "competence" in management: D.Bertram, R.Bojaciš, T.Džuran, K.Keen, J.P.Campbel, M.Kellinan, D.McClelland, S.B.Perry, I.T.Robertson, M.Lails, Spenser and Sains M.Spenser, R.White, and pedagogy: J.Delor, V.Hutmahers, J.A.Keller, I.Maslo, F.Novak, A.Rauhvargers, I.Tilla, J.Ravens, I.Zimnaja.

**Results:** Competence is a multi component structure, including such components as the cognitive, social, emotional etc. and such elements of competence as knowledge, skills, attitudes, which provide an implementation of a high professional activity and a development of specialist's personality. Service competence is an integral totality of personality's qualities possessed by a hospitality manager, representing personal, cross-cultural/social and professional competences (see Table 1).

Table 1. Hospitality manager's service competence

Competence structure	Characterization of competence	
Personality competences	Competences related to oneself as a personality and as a subject with ability to act.	Characterize personality's identity and maturity, emotions, perception of the world, tolerance, loyalty, receptiveness to the new, unusual and strange et al.
Cross-cultural competences	Competences related to manager's interaction with guests.	Characterize manager's communication features and behaviour in a multi ethnic environment. It is an ability to adapt and to make contacts with representatives of the various nationalities, as well as an ability to listen to others et al.
Professional competences	Competences related to manager's activity, expressed in various types and forms.	Characterize manager in the profession, one's work experience, skills acquired during the work, knowledge within the professional field and ability to apply this information based on knowledge, skills and attitudes.

Source: Research of the author I.Kulisha

**Conclusions:** The author has created and offers a service competency structure of hospitality managers. Service competency structure of hospitality managers- is a whole complex, which characterizes a hospitality manager's behaviour performing a professional activity.

# Promotion of learning process by project's

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Keywords: project learning, semestral project, biophysics

**Background, framework and purpose:** Project learning is used in different modifications in dependence of expected teaching aims. Sometimes, this activating form of learning is combined with traditional one. A specific model of project learning in biophysics applied at the Comenius University Faculty of Medicine in Bratislava is analysed in our study. Semestral projects processed by 1st year students of General Medicine represent a compulsory form of teaching.

**Methods:** The contentual analysis of semestral projects (acad. year 2009/2010) was made with the aim:

- to compare obtained results with analyses in previous academic years;
- to summarize the wide spectrum of physical applications in medical diagnostic and therapeutic methods, safety problems related with them and physical principles of medical equipment;
- to confirm usefulness of project learning.

**Results:** Based on obtained results we have confirmed the feasibility of project learning in biophysics. It facilitates cognitive and other key competencies developed by physically oriented teaching subjects and supports both individual and team study activities. Besides the other teaching and learning forms it represents an effective teaching tool that is positively evaluated by students.

**Conclusions and implications:** Our analysis has showed:

- a wide spectrum of partial physical topics connected with medical applications reflecting actual needs of medical practice;
- low frequent/difficult topics of semestral projects motivate teachers to pay more attention to them in the teaching process;
- project learning supports cognitive and other key competencies developed by physically oriented teaching subjects effectively;

Moreover it can be noted necessity of:

- dynamic and selective enlistment of new scientific information into syllabus of biophysics;
- cooperation with both other teaching subjects (radiology, nuclear medicine) and clinical workplaces regarding retention of physical knowledge;
- improving and supporting another alternative forms of medical study (optional teaching subjects, students scientific activities, final projects, diploma thesis).

Based on obtained results it can be underlined feasibility of modified project learning in the biophysics, that can be applied in physically oriented teaching subjects in the non-physical study programs generally.

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## Project-based teaching the topic: „CHEMISTRY OF MILK“

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The aim of the paper is to inform chemistry teachers about project-based teaching the topic Chemistry of Milk. At the same time the paper serves as a handbook of setting up projects on the topic.

The subject matter is topical in connection with the current situation in milk and dairy products consumption in Slovakia. The topic thus becomes an issue of healthy diet, too. Nutrition and healthy diet experts rank milk the most important, most complete and most wide-spread food. Bad eating habits along with different myths about harmfulness of milk have contributed to a low consumption of milk in Slovakia and other Central European countries as well.

The topic Milk is suitable for setting up a school interdisciplinary project (chemistry - ecology – biology), which affects educational subject matters of The State Educational Programmes Man and Nature, Man and Society, Health and Movement as well as Environmental Education.

In the paper we propose projects with the titles Milk – What We (Don't) Know about It and Milk on the Way to the Table according to the so-called 4-level plan which has been both worked out for project teaching in chemistry and tested by Demuth. Its substance lies in working out the following parts of the project: introduction to the subject matter – motivation, common planning – outlining basic aims and procedures, division of theoretical and practical tasks and functions in teams. The implementation itself, presentation and evaluation of the project results. A frequent problem of project work is an unsatisfactory level of pupils' input knowledge, a problem which has to be solved either by a teacher by supplying knowledge in the teaching process or by pupils by self-study. In the case of the milk project the following knowledge is to be taught, supplemented and consolidated: chemical substance of milk, processing and modification of milk, kinds of milk, its history and influence on human body, healthy diet point of view, primary production of milk, storage, distribution and selling of milk, milk industry in Slovakia, etc.



In project work a teacher uses different methods and forms, such as individual and team work of pupils, lesson, laboratory work, excursion, carrying out chemical experiments, work with mobile analytical equipment – various kinds of chemistry tool boxes – and different forms of project results presentation. All these develop pupils' creativity and put emphasis on their activity and co-operation.

In the paper we also present specific examples of primary and secondary school pupils project work on milk topic that were presented in the project competition organised within KEGA 3/6301/08 project Educating chemistry and science teachers in selected topics of Steadily Sustainable Development by means of blended learning in the school year 2008/2009.

The pupils involved in the project work have stated clearly that project learning has changed pupils' attitude to chemistry, they have realised the significance of consuming milk and have got interested in the quality of food they commonly eat and they have emphasised that knowledge of chemistry is necessary for them.

This paper has been completed with the support of KEGA 3/6301/08 and LPP 0131-06 Ministry of Education of the Slovak Republic.

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# Teaching strategies and methods in croatian primary school science education

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Keywords: primary education, science education, child centred education, teaching strategies and methods, Croatia

This paper tries to show teachers' attitudes towards the teaching strategies and methods in science education which are used most frequently and are most applicable in science education in Croatian primary schools.

The paper presents the results of the research conducted with primary school teachers in Croatia (N = 30) who teach in grades 1 – 4. Teachers were asked to fill in the questioner and to estimate which teaching strategies and methods they use most often in science education. Teachers evaluated which teaching strategies and methods are most applicable to science education (teaching strategies whether they are working in a small group of students, big group of students or when working individually with students). Some of the teaching strategies being assessed were: demonstration, discussion, questions and answers, video recording, use of ICT in the classroom. They assessed workshops, games, brain storming, ice breakers, project work, tutoring, and on line learning as well. Also, teachers were asked to assess the use of methods such as practical work (hands on), visual and verbal methods, drawing, dialog or monologue methods, reading and writing.

After assessing the usage and application of each strategy as well as the method teachers were asked to assess different forms of classroom teaching (lecture, working individually, working in pairs, differentiated and non-differentiated group work, working in cycles). Teachers were asked to rank these strategies and methods on the bases of their influence on development of critical thinking, active learning, development of student creativity in science education.

At the end teacher's assessed the level of competence for using each of strategies and methods in science education and their ability to ensure child centred science education.

Implications of this work will be of great help in creating curriculum for future teachers as well as the development of primary school science curriculum.





# Chemistry in the Mirror of a CD – Experiments with the Compact Disc

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Keywords: Chemistry, school experiments, new materials

Three years ago, the Compact Disc celebrated its 25th anniversary. The first CD (Compact Disc Audio Digital) worldwide was launched on the market by the EDC company from Langenhagen near Hannover as a sound storage medium and a success story was begun. A few years later, the CD-ROM as a general data storage medium was added. Then came the CD-R, the CD-RW and eventually the generation of the DVDs. The CD as an innovative medium for data storage has reached a remarkable presence in many areas of our life.

CDs are an inexpensive and robust storage medium. Even though the durability of the material and thereby the usability of a CD is estimated to be 5000 years which is extremely high, more and more CDs are disposed (Roth, 2007). Methods of recycling and re-using old CDs become more and more relevant. Especially the polycarbonat of the disc is a sought-after resource. The CD-ROM is often called „silver disc” because of its metallic shining. This shining of the CD-ROM however results from the vaporisation of the round plastic disc with aluminium. In contrast to the CD-ROM, on the CD-R there is in fact a thin silver coating.

Proposals for school experiments have been made in recent years concerning the different aspects of the material composition of both the CD-ROM and the CD-R, and concerning the possibilities of the material recycling for CDs (Bader et al., 2000). These proposals will be summarized in this presentation. In addition to this, newly developed experiments are presented showing in a demonstrative way and with special aesthetics that there really is a very thin coating of aluminium or silver respectively on each CD. These experiments link in a functionally coherent manner the special redox chemistry of both metals with aspects from analytics, complex chemistry and electric chemistry (Lühken et al., 2009).

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# Using molecular modelling to enhance and enthrall in chemistry education

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Computational chemistry is the fastest evolving discipline in chemistry. Traditionally, chemistry has been considered as an experimental subject but due to the vast growth and development in computer technology, the computer-based approaches are becoming more widely adapted in research and education.

To support the use and application of modern computer-assisted methods in chemistry education, a special modelling and visualisation course for chemistry educators has been developed. The course originates from the new educational programme introduced in Finnish secondary and high schools by the National Board of Education. The course introduces computational chemistry and computer-assisted visualisation as a modern research and educational tool to enlighten important topics and concepts within the scientific discipline. The topics considered during the course are, for example, energy, stereochemistry, chemical bonding and chemical reactions – all concepts and phenomena appearing in the new educational programme but being traditionally considered very difficult and complex subjects even at university level chemistry education. The computational methods used are based on modern state-of-the-art computational chemistry research approaches but they are applied with a strong educational bias. The course involves interactive lectures, hands-on sessions in the computer laboratory and practical exercises to demonstrate the power and applicability of the approaches in educational framework. Chemistry education research is adapted during the course in order to understand the effectiveness of modelling and visualisation in teaching.

Our goal is to give chemistry educators a first-hand experience and training to use computational chemistry methods as well as ICT (information and communication technologies) in studying, teaching and understanding chemistry. The course and all its ideas originate from longstanding excellence in computer-assisted chemistry research. Now this knowledge is emerging in chemistry education as a standard educational tool with a strong emphasis of more efficient and more comprehensive understanding of chemistry. The “computational chemistry in chemistry education” course represents a synthesis of high-level scientific research and wide educational experience, which will modernise chemical education on every national and international educational frontier.



## The teaching of radiations using an historic-philosophical approach

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Three great scientific discoveries occurred by the end of nineteenth century – X rays discovered by Roentgen in 1895, radioactivity by Becquerel in 1896 and the electron by J.J. Thomson in 1897. These discoveries and their consequences were in the origin of deep changes in the scientific views about the constitution of matter. They also had tremendous social impacts because of their applications in various fields – from physics and chemistry to medicine and many others in daily life that usually are not recognized as related to radiations.

The X rays and radioactivity, unknown until a certain time in history of science and obviously not included by then in teaching programs, actually constitute the departing point of a new physics-chemistry. The teaching of this subject sometimes problematic, although fascinating, will acquire more significance and clarity if an historical approach is used in the presentation and development of the topics. Philosophy of science also can bring a positive contribution in the teaching/learning of the new physics and chemistry, not only by the introduction of epistemological considerations, but also by posing various ethical questions.

In order to point out the potentiality of the role of history and philosophy of science in the teaching of physics and chemistry, in particular in what radiations are concerned, some examples will be presented. Among the examples, a teaching module that starts with the discovery and evolution of the gas discharges presenting the three discoveries mentioned above and their consequences, and proposing alternative approaches to different topics, like the atomic models or the periodic table, will be detailed.



# Integrating an ePortfolio into an Undergraduate Teacher Training programme: A voyage of discovery!

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Keywords: ePortfolio, PDP, online learning.

Web 2.0 based technologies can have a liberating and engaging affect and many ePortfolio systems make use of these relatively new technologies. This paper reflects on the integration and implementation of ePortfolio software into a first year undergraduate teacher training programme for students training to teach in primary schools. As Hallam et al. (2008) point out

The use of electronic portfolios in teacher education as well as within the professional context is emerging as fundamental to professional development (p. 40).

This process took over 2 years and included:

- Selecting the e-portfolio software
- Redesigning the teaching programmes to take full advantages of e-portfolios
- Providing training for both staff and students
- Surveys of participating students and academic staff

The software was chosen from a number of viable alternatives. The criteria used for this selection are discussed within the paper. The ePortfolio selected seemed to offer the best compromise between flexibility, ease of use, scalability, cost and portability.

It is intended to use the ePortfolio to encourage students to develop a culture of critical reflection and become more responsible for their own learning needs (Lambert & Corrin 2007). The training was designed with an awareness of the differing needs of the many types of students our courses attract and the needs of the tutors involved. It is thought that younger students would have more of the skills needed to create and use e-portfolios as they have used 'life portfolios' with applications such as facebook (social networking), whereas the more mature students were thought to need more support. However, initial findings suggest the situation is more complex.

At the end of the first programme both staff and students were surveyed to establish their views and thoughts on the use of electronic portfolios; results from this informed decisions made with regard to modifications needed for the more efficient integration and expansion of the use of ePortfolios.

Key findings indicate a greater need for training both staff and students than was initially predicted. The common assumption that all students have an adequate level of computer literacy is challenged. Staff moving into the area of new technologies for the first time, may have misconceptions that are difficult to identify.

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# Small-group discovery-based learning method as a mean to teach scientific method and the nature of science with a very simple experiment

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Key words: small-group discovery-based learning, experiment with a burning candle, nature of science

One of the basic topics in science teaching should be the relation and relevance of science to cultural and societal development. But, the reality of classroom practice is different; in the majority of cases predominant teaching method is instructional (deductive, top-to-bottom approach), i.e. the teachers present the concepts, their logical implications and give examples of applications. Correspondingly, science appears to students as a rigid system of trivial facts that should be memorized. As a result wrong perception of science is developed.

In contrast to that, the use of a small-group discovery-based learning strategy (Judaš, 2010) as general teaching method makes it possible to show that science is a creative process in which everyone can participate.

To provide better understanding of the nature of science and of the phenomena occurring during the burning candle experiment we have developed a workshop based on small-group discovery-based learning. The goal of the workshop was to test the volume-percentage hypotheses by a series of carefully conducted experiments. The results obtained by students' team-work were discussed and have unambiguously shown that the results of the experiment are very dependent on the experimental procedure and that it cannot be used to demonstrate the percentage of oxygen in the air. This was also clearly demonstrated by conducting the experiment in a closed system: the candle could be repeatedly lighted, demonstrating that flame exhaustion is not related to complete oxygen depletion, but by the other factors (Tawarah, 1987; Peckham, 1993; Birk & Lawson, 1999; Krnel & Gložar, 2001).

Through this experiment, students are faced with a real and interdisciplinary scientific problem. To solve it, they must use the knowledge of physical and chemical concepts they have acquired so far, discuss the facts, confront ideas and discard them on the basis of facts.

Correspondingly, small-group discovery-based learning presents science as a creative, dynamic, intellectually and emotionally involving, endeavour.

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# Multiple intelligences of college chemistry students: their relationship to chemistry achievement

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This is descriptive correlational research aimed to determine the dominant intelligence of college chemistry students. It also sought the relationship between Multiple Intelligence scores and chemistry achievement scores classified into three cognitive levels; knowledge, comprehension, and application.

The study was conducted at De La Salle University-Dasmariñas, Cavite, Philippines with a sample composed of a total of 855 students. These students came from a total of 23 different classes with different courses taking general chemistry.

A multiple intelligence inventory test and a 100 – item multiple choice chemistry achievement tests were used to gather data. Pearson r coefficient of correlation was used to determine if there is a significant relationship between the scores in dominant intelligence and the different cognitive levels of chemistry achievement test (knowledge, comprehension, and application). To test the significance of r, t – test (2-tail) was used at 0.05 level of significance.

The findings of the study revealed that students possess different dominant intelligence. The dominant intelligence of Bachelor of Science in Nursing (BSN), Bachelor of Science in Physical Therapy (PPT), and Bachelor of Science in Radiologic Technology (RAD) is interpersonal intelligence, Bachelor of Arts in Communication (COM) and Bachelor of Arts in Journalism (JOU) is verbal intelligence, and Bachelor of Science in Industrial Technology (INT) and Bachelor of Secondary Education (BSE) is logical intelligence.

The study also showed that interpersonal, naturalistic, intrapersonal, verbal, and logical students performed better compared to other MI groups in chemistry achievement test. Positive correlations were found between dominant intelligence scores and mean scores in knowledge level of interpersonal, intrapersonal, verbal, logical and visual students. Positive correlations were also found between dominant intelligence scores and mean scores in comprehension level of interpersonal, intrapersonal, verbal, and logical students. Application mean scores have positive correlations with dominant intelligence scores of interpersonal, naturalistic, and logical students.

Based on the findings of the study, the following conclusions were made: College students differ in the dominant intelligence they manifest. There is a significant relationship between the scores in dominant intelligence and the scores in each of the three cognitive levels of chemistry achievement test.

## The bilingual teaching of biology in Polish high schools

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The bilingual teaching appeared in Europe in the 19th century as a opportunity to learn two languages: the official language and the language of minority. Nevertheless, the biggest development was noticed in the 90's of 20th century when many European schools decided to start bilingual teaching.

Nowadays, there are many primary, secondary and post-secondary schools which offer this type of teaching in many European countries.

The bilingual teaching changes and improves dynamically because of the significant interests of students, parents and teachers but also because it must fit to European Standards of education. Unfortunately, there is no coherent programme for all countries involved in bilingual teaching. Moreover, the school staff lacks the qualifications needed for the following various curricula and bilingual teaching. This results in teaching from various academic sources. The level of teaching is not standardised and to a large extent, depends on the teacher's qualifications and language skills.

Our work presents diagnostic investigation of the group of 100 students taking biology in bilingual system in Polish post-secondary schools. The investigation is based on a diagnostic questionnaire about the teachers' qualifications, the quality and the effectiveness of teaching.

## Evolution of student teachers' conceptions about light following constructivist didactic activities

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Keywords: Canada (Quebec), training teacher, primary school, constructivist didactic activities, light

A review of various researches on the sensitive issue of sciences in elementary schools indicates that students show a fascinating curiosity to understand the material environment with which they interact and, consequently, they develop different conceptions prior to any formal teaching. However, despite the functional and operational role of these conceptions, these misconceptions may conflict with accepted scientific theories (Sharp, 1996; Selley, 1996; Potari & Spiliotopoulou, 1996). In order to change these misconceptions, a few studies reveal that it is possible to implement instructional and learning strategies eliciting both students' naïve conceptions and scientific conceptions (Canal, 1986; Invernizzi, Marioni & Sabadini, 1989; Ravanis & Papamichaël, 1995). Still, we have noticed that, in spite of the evident contribution of

these researches, teacher's education constitutes a major obstacle to their implementation in the classroom. Indeed, researches conducted among others in England and Australia (Kruger & Palacio, 1992) show some astounding analogies between children's spontaneous conceptions and those of the teachers. The present communication aims at, on one hand, studying the misconceptions of a hundred and nineteen (119) student teachers' enrolled in an elementary education bachelor's program, in relation to the rectilinear propagation model of light. We proceeded to elicit the misconceptions, with classical methods such as a paper-pencil questionnaire. We have retained four simple questions to identify student misconceptions about shadow and light. It should be noted that these questions were based on the works done worldwide on pupils' misconceptions about light. On the other hand, an approach based on the idea of conceptual conflict was experimented with these student teachers in order to facilitate the learning of the model. An approach centered on the idea of conceptual conflict was used to facilitate the learning of the model of light's rectilinear propagation. Thus, during three sessions of three hours each, we managed to get a majority of subjects to solve problems involving the understanding of the aforementioned model. They went along the indispensable conceptual path to build the model in four steps (First step: A few experiments on light prior any teaching - Second step: Interpretations of experiments - Third step: Some further enhancing learning activities - Fourth step: a few problems on light after teaching). Thus, we managed to bring a significant proportion of student teachers to realize the conceptual path necessary to assimilate the rectilinear propagation model of light, the steps of which shall be introduced here.

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# Students' representations in teacher education on magnetism in Quebec (Canada)

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Keywords: training teacher, Canada, primary school, representation, magnetism

Researches in didactics on the representations of the pupils on magnetism and electromagnetism are rare, compared with those in electricity, mechanics and optics (Bagheri-Crosson and Venturini, 2006; Maarouf and Benyamna, 1997; Borges and Gilbert, 1998). In the case of the phenomenon of magnetization and of demagnetization, Maarouf and Benyamna (1997) showed that the majority of the pupils of the secondary (from 13 to 20 years old) have a representation of the magnetization which implies a "linear causative" reasoning. In this representation, magnetization results for example from the passage of something of an agent (from magnetic field source) to a patient (object to be magnetized). The present communication follows this line of research and has the objective to introduce representations on magnetism spotted at students of Quebec (Canada) in teacher education for primary school. One hundred-twenty-six (126) students participated in this study and they are registered in second year of university in the baccalaureate program in primary education which is of a length of four years. These students came from the sector of human sciences and they all followed, during their secondary education, a general course in physical or biological sciences. Forty-three (43) of them took no course on magnetism and eighty-three (83) studied as part of general physics course some notions linked up with magnetism, such as attraction and repulsion between magnets, temporary magnetization of a material and the spreading of the iron filings around a magnet. To identify their representations on magnetic phenomena, they answered a questionnaire including nine (9) statements and had to specify if each was true or wrong, by justifying their choice. The stage of justification is important since it allows to be sure that the choice of the student is not unpredictable and is founded on a clarified reasoning. Also, at the end of the questionnaire, they were asked two open questions on what a magnetic field is and how to explain that a magnet remains glued on the door of a refrigerator. In this communication, we are going to specify objectives followed by each of the questions and their analysis. Results show that some of their representations are similar to those identified in aforementioned researches, more particularly "linear causative" representation. Moreover, we are going to see that most frequent representation is the one who considers that a magnet has two charged poles positively and negatively (as in the case of an electrical pile) and that magnetization and demagnetization result from an attraction or from a repulsion in accordance with the law of electrostatics charges.

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## Climatic challenges educated for prospective teachers of geography

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Weather and climate are important conditions for our everyday life, and also frequent topics of the media. For the teachers this means a life-long challenge to be always informed when contacting the students. Teachers of geography are especially involved in this respect, so curricula of their higher education should prepare them for this role, accordingly.

The study presents four subjects of the regular curricula in the College represented by the authors. They are “Meteorology and hydrology” and “Renewable energy sources” in the BSc. programme, “Atmospheric risks and resources” and “Climate change, impacts and responses” in the MA education. These subjects provide the necessary topical information for the students, but the paper would not overload our teacher-mates with the professional details. Our aim is rather to comprehend the climate-related moments of our life and of wider aspects of the environment.

In the sequence of the subjects, they are the continuous technological innovation, leading to ever developing services; the technological and social conditions supporting or limiting the ideal carbon-free way of living; the series of examples to accept precautionary measures in connection with the atmospheric risks and the smarter site-specific consumption of our natural resources. The climate change subject provides good opportunity to present the related problems of the environment, stemmed from the same anthropogenic over-consumption of the natural resources. This last subject claims for integration of these moments into long-term tasks for the whole society.

To put the message in wider scope, the paper presents a few methodological subjects of the MA education, aiming to prepare the prospective teachers to motivate their pupils for responsible, environment-oriented attitude and to improve their science-based problem solving abilities.



# Calculate with LEGO-Method! – Practice for Chemistry Teachers

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Keywords: Chemistry, problem solving, LEGO-Method, building block, basic panel

Skills of problem solving are necessary to engineering or scientific fundamentals of students even if the chemistry course is not their professional subject. Some classical and effective methods are used in chemistry education for calculating (e.g. dimensional analysis, proportionality-method or rule of three, mole-concept, etc.), but students usually do not like to solve chemistry problems, because it seems to be very difficult for them.

One of the new procedures is the LEGO®-method, which was invented by us for problem solving (Molnár 2005, 2006). The relations of mole and the molar amounts, as small perspicuous units (building blocks), are applied on a fundamental relationship (basic panel) and the problem can be solved as an algebraic operation (Molnár-Hamvas 2007).

Just a single one relationship or basic panel is used in the calculations, and it is enough to solve almost any type of chemical problems:

$$n_{\text{unknown}} = \frac{u_{\text{unknown}}}{u_{\text{given}}} \cdot n_{\text{given}}$$

The “u” coefficients of the given and the unknown amounts are whole numbers (e.g. the coefficients of balanced chemical equation).

The building blocks are simple relations, which connect the mole with different physical amounts (e.g. number of particle, mass, volume), e.g.:

$$n = \frac{N}{N_A} \quad n = \frac{m}{M} \quad n = \frac{V_{\text{gas}}}{V_m} \quad n = \frac{p \cdot V}{R \cdot T} \quad n_e = \frac{I \cdot t}{F} \quad n = \frac{\pi \cdot V}{R \cdot T} \quad n = c \cdot V_{\text{sol}}$$

The building blocks of the expression of different concentrations, ratios or percentages, and density are added to these in the case of mixtures or solutions e.g.:

$$c_i = \frac{m_i}{V_{\text{solution}}} \quad c_R = \frac{n}{m_{\text{solvent}}} \quad X_i = \frac{n_i}{n_{\text{total}}} \quad w_i = 100 \cdot \frac{m_i}{m_{\text{total}}} \quad \rho = \frac{m}{V}$$

This method does not require students to memorize the final formula of calculations, but only to use the panel and building blocks. The first step of the problem solving is determining the coefficients, the second is arranging of building blocks, and the last is applying them to the basic panel. Lots of examples for LEGO®-method will be demonstrated on the workshop.

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# How Students in Croatian Secondary Schools Understand Chemical Equilibrium

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Keywords: chemical equilibrium, Croatian schools, conceptual understanding

Chemical equilibrium is one of the basic concepts in both secondary schools and university chemistry curriculum and it was a subject of many educational studies(1,2). Often misconceptions in understanding of its dynamic nature have been found. Some problems concerning the chemical equilibrium have been set in the State graduation exam for secondary schools officially carried out for the first time in the 2009/2010 academic year as well as in the experimental State graduation exams of 2007 to 2009. This research was inspired by inadequate results of mentioned experimental exams.

In total, the sample of 220 freshmen of the Faculty of Science having six year chemistry education was observed through 2007 to 2009 period. The aim of the research was to find out: (i) the level of understanding of the chemical equilibrium, (ii) the most frequent alternative concepts of understanding the chemical equilibrium, (iii) the level of durability of knowledge acquired in secondary school, as well as its applicability in the university subject of General Chemistry, and (iv) the appropriateness of questions asked in the experimental State graduation exams of 2007 to 2009. Our test comprised of three open-ended questions. Two of these questions have already been asked in experimental State graduation exams of 2007 to 2009, and the third one was based on the model of “Conceptual Questions” on Le Chatelier’s Principle(3).

The issue of understanding the concept of chemical equilibrium has not been investigated in Croatia until now, neither over students or teachers population. The observed groups of freshmen exhibited the most of the misconceptions already described in chemical education literature. Similarly as it had been shown by the other authors(4), we found that misunderstanding is present on the conceptual as well as on the symbolic level. In order to understand the background of the situation, we plan to submit the teachers community to the similar investigation.

It is planned to make good use of the findings on the misconceptions about chemical equilibrium (i) in life-long learning education for in-service teachers, (ii) in lectures of Methods of teaching chemistry as a subject in pre-service teacher study programme, (iii) in development of didactic methods to help students understand dynamic chemical equilibrium using animations on interactive whiteboard.

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## From research to the classroom

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Keywords: High School education, experimental projects, laboratory research, inductive learning

**Background:** Within the new programs for High School education in Mexico (secondary level), a series of obligatory projects are established which comprehend from the first ones being very directed to the ones in the last unit, in which projects are more open and allow the student to have the decision making process and the election by themselves of methods and alternatives to follow.

One of the latter ones is a project that tries to relate art to chemistry. In this context, an experimental project similar to the one carried out in the research area was proposed during the guidance of a formal doctoral thesis.

**Objective:** The academic objective which was considered is that the student follows the steps for formal research and which implies not only the presentation of a problem and election of a method but also a handling of all the involved variables.

On the basis of the previously indicated objective, the preservation of archaeological pieces by means of a process with natural gelatin was chosen and that has proven to be efficient in very old and deteriorated pieces.

**Methods:** The principle on which the process is based is in the use of gelatin in concentration of 1%, which is applied with a spray trying to cover all the pores of the chosen piece. Gelatin displays major durability and is free of undesirable bacteria and fungi by means of adding food preservatives (sodium sorbate and potassium benzoate), whose concentration is maximized when 1% of each are used, but presents a challenge for the students who initiate their experimentation using different concentrations for the preservatives.

The other factor of the experiment implies the addition of formaldehyde to prevent the decomposition of the gelatin by microbial effect. In this case, the addition of the formaldehyde at different times is experienced in the process of dissolution and application of the gelatin. The student also experiments here adding the formaldehyde to the beginning, in the middle and at the end of the process and thus following a mental process similar to the one of the researcher; he then chooses in which of them the process becomes more efficient and prevents the premature denaturing of the gelatin.

**Results, conclusions and implications:** The application of this project has allowed the student to systematize his experimental data and enables him to make decisions about the variables involved in the process; besides fomenting in them procedural as well as attitudinal competences.

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# Educational technology applications in lifelong learning of Science

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Educational technology, especially computers and computer-related peripherals, have grown tremendously and have permeated all areas of our lives. Information and Communication Technology (ICT) Literacy reflects the need for students to develop learning skills that enable them to think critically, analyze information, communicate, collaborate, and problem-solve, and the essential role that technology plays in realizing these learning skills in today's knowledge-based society. Investigating the impact of technology use on higher order thinking skills as measured through means other than standardized tests. They are examining students' ability to understand complex phenomena, analyze and synthesize multiple sources of information, and build representations of their own knowledge. At the same time, some researchers are calling for newer standardized assessments that emphasize the ability to access, interpret, and synthesize information. The effectiveness of educational technology on student learning depends not only on what outcomes are targeted and how the technology is integrated into instruction, but also on how teachers assess student performance in classrooms and adjust instruction accordingly. Technology offers teachers a broad range of tools to collect and analyze data, and richer sets of student data to guide instructional decisions. Teachers tend to use multiple sources of data—homework assignments, in-class tests, classroom performances, and experiential information—to inform their thinking about their students strengths and weaknesses. Another factor influencing the impact of technology on student achievement is that changes in classroom technologies correlate to changes in other educational factors as well. Originally the determination of student achievement was based on traditional methods of social scientific investigation: it asked whether there was a specific, causal relationship between one thing—technology—and another—student achievement. The present paper work examines Specific educational goals and a vision of learning through technology in the following aspects mentioned below.

1. Ongoing professional development
2. Structural changes in the school day
3. A robust technical infrastructure and technical support
4. Ongoing evaluation

The experiment was carried on a group of engineering students in the age group 19-21 years including boys and girls. Application of educational technology forms an integral part in exposing the students to knowledge resources which helps in building professional development. Therefore, a questionnaire was prepared evaluating the four aspects.

**Result and discussions:** It was found that there is strong relationship between a robust technical infrastructure and technical support and Ongoing professional development. This proves that technical support is an essential to understand it.

# The Influence of Visualisation on Pupils' Understanding of Chemical Reactions

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Keywords: didactics of chemistry, animated modelling of the micro-world

**Background, framework, and purpose:** In Polish curriculum of chemistry for the pupils of lower secondary school, there are many terms concerning chemical reactions that pupils are supposed to know, for example they are supposed to be able to describe differences in the process of a physical phenomenon and a chemical reaction as well as to give examples of both processes in human environment. Pupils are also expected to be able to plan and carry out experiments illustrating a physical phenomenon and a chemical reaction, describe the reactions of synthesis, analysis and substitution as well as to formulate appropriate chemical equations, point to substrates and products, and choose coefficients [Nodzyńska, Paško 1999].

In order to make pupils acquainted with the world of chemical reactions, teachers conduct many experiments during lessons. However, a chemical experiment, though indispensable during lessons, does not facilitate pupils understand the world of chemistry. To explain pupils WHY particular chemical reactions occur we have to move from the macro-world (a world of real chemical experiments) to the micro-world, a world of chemical individuals: atoms, ions, and particles. The introduction of models in chemistry instruction aims at helping pupils in lower secondary school understand the terms of the micro-world [Nodzyńska 2005a,b; Nodzyńska, Paško 2006].

**Methods:** In order to make pupils acquainted with the process of chemical reactions, computer animated models have been created in Flash. The main assumptions of the computer animated models include: they show spatial structure on the micro-world level, they show movements of chemical individuals in solids, liquids, and gases, in these models, proportions between individual atoms in particles as well as between ions are maintained, chemical individuals do not have clear-cut boundary, and the computer models show the structure of electron cloud in a blurred way, without boundaries, they take into account the theory of Brownian motion, they show that atoms, ions, and particles are colourless, they make it possible to repeat the reaction with pointing to its particular stages, they make allowances for simplifications which are due to the pupils' level of knowledge [Nodzyńska, Paško 2004].

The research whose aim was to check the influence of animation on pupils' comprehension of terms related to the notion of "chemical reaction" was conducted in IX 2008 in 4 first grades of lower secondary school. The research was carried out in accordance with the method of pedagogical experiment, using the technique of parallel groups. The research included 4 groups of pupils:

1. an experimental group into which an operand (computer animation) was introduced;
2. a monitoring group (2) in which lessons were performed with the help of a written text (textbook, worksheet);
3. a monitoring group (3) in which lessons were performed with the help of didactic materials that referred to the auditory channel (teacher's lecture);
4. a monitoring group (4) in which pupils made experiments themselves during lessons.

Lessons, in the experimental as well as in the monitoring groups, were held by the same





teacher, who based on the same lesson plans; the only difference stemmed from different materials used. During the lesson pupils were presented the reaction of burning carbon in oxygen and the ways of identifying the reaction products with the help of lime water (pupils should know the process of identifying CO<sub>2</sub> from their primary school education). After the lesson in all groups, pupils were asked to answer four questions in a questionnaire.

**Results:** All the pupils answered the first question concerning the signs of the reaction. The most diverse answers were found among the pupils of the experimental group (11 different answers) and the least diverse among the pupils of the monitoring group 4 (who worked with texts only). Despite such a diversity, all the answers given by the pupils from the experimental group were correct, and 12% of pupils could draw a model of the reaction process. Among the pupils from the monitoring groups, answers were often imprecise or wrong; for example 30% of pupils from the monitoring group 3 wrote that the “burning of oxygen” was a sign of the reaction, 4% of pupils from the group 2 held that water merged with oxygen, and 5% of pupils from the group 4 claimed that “lime water becomes invisible.”

The second question dealt with the definition of a chemical reaction. In this case all the pupils from the experimental group gave a correct answer. In the case of pupils from the monitoring group 2 there were 29% of correct answers, the monitoring group 3 – 73%, and the group (4) – 100%.

In task 3 pupils were asked to write down the process of the chemical reaction that was discussed during the lesson. In the experimental group all the pupils gave the correct answer: 27% of pupils wrote correctly the reaction of burning carbon (out of whom 19% used chemical symbols), while 77% of pupils gave the answer by drawing the reaction in the micro-world (some pupils gave the answer by both writing down and drawing the process of the chemical reaction). In the monitoring group 2 there were 89% of correct answers, in the monitoring class 3 – 60%, and in the monitoring group 4 – 64% of correct answers.

The fourth question was related to this stage of the lesson which was held in the same way in all four groups and the answers given by pupils are similar. In the experimental group 92% of pupils claim that cloudiness of lime water is caused by carbon oxide (IV) exhaled from our lungs, and in the monitoring groups 82%, 97%, and 96% of pupils respectively gave the same answer.

**Conclusions and implications:** Summing up, it may be stated that the computer animation shown to the pupils from the experimental group has led to a better understanding of the process of chemical reactions. Those pupils also learnt to describe this phenomenon using the terms of the micro-world.

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# Comparative analysis of the quality of science and chemical education in Latin America

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The actual situation and perspectives of science and chemical education of any countries is very important topic for educational administrations, teachers and researchers. Latin American (LA) region has more than 570 millions of inhabitants and the half of them are young people. There are some important points of analysis of the quality of science and chemical education there: 1. Basic statistic data about students and teachers in the secondary, high and highest levels of education; 2. The existence and the contents of the curriculum standards for science and math education; 3. The results of national and international science exams and testing; 4. Characteristic of current science curriculum and textbooks and using of computers and educational software of good quality; 5. Results of national and international science Olympiads; 6. Assessment processes in the teaching of science subjects; 7. Training of science teachers at the university; 8. The existence of the special systems for improving the level of educational qualification of in-service teachers; 9. The academic ranking of LA universities.

According to these data the LA countries has a lot of problems and difficulties in their educational systems (De Witt et al, 2005). Many of young scholars are out of educational systems in primary, secondary and high school levels. Some countries have millions of illiterate population among young and adults (Education, science and technology, 2006) Almost all countries apply the curriculum standards for science and math education, but these standards should be improved in many cases. The results of national and international science exams and testing show, that generally students have rather low level of knowledge and abilities. In many countries the quality of science curriculum and textbooks should be improved too. More efforts should be done for designing and use the good educational software for science and math education in the school and university levels. Some times students of LA region stand in good level taking part in the international science Olympiads; in many countries the number of students who participate in the national olympiads should be higher. Many countries should improve the assessment and evaluations processes in the teaching of science subjects and to rise the quality of the process of training science teachers at the university. Most of LA countries do not have the special systems for improving the level of educational qualification of in-service teachers (Cuba is an exception in this case) (Orlik, 2009). The academic ranking of many LA universities should be improved too. In this work another measures for improving the current situation will be shown.

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# Study of media content in the Slovak language focused on science issues

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Keywords: media content, science communication, science education, content analyze

It looks like very useful to study communication phenomena in educational domain. This moment is more interesting nowadays because of the communication issues become to the centre of political and social interest in the form of setting apart the key competence that indicates the goal orientation of the European education system.

It's apparent this competence is predominantly saturated by maternal languages and foreign languages. The place of the science education in this topic is represented by science communication. Theoretical study of this issue indicates it would be probably an intra-epistemic communication (communication about results of science among scientists) and the general science communication (communication that determines relation between the science and the public opinion).

The contribution presents conclusions of the empirical analyze focused on the science media content and its potential determination of the implementation of the communication competence in the science education. The basic method used in this study was the media content analyze and the theoretical reflection of the potential impact on the science education content.

# Elements of experiential education and adventure education in pre-gradual preparation of science subjects teachers

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The aim of this contribution is to inform about possibilities to apply elements experiential and adventure education in pre-gradual preparation of science subjects' teachers, who are under preparation in teaching process, it means also upbringing and educational process.

Experiential education (pedagogy) is a pedagogical direction, which in past few days on the bases of changing cultural and social influences has been receiving more attention and has become an important part of pedagogy. Personal activity of an individual is the bases of experiential education, where an individual goes through an intensive experience which touches his/her intellectual and emotional aspects. The more energy an individual put in, the more intensive experience is. A teacher in context with his/her position in teaching process has to endeavour to reach a pedagogical experience – an experience, which has ability to positively influence and leads to self-reflexion of an individual. The basic principle of experiential pedagogy is a spontaneousness of acquiring curriculum, interaction of leaning by playful form and subsequent action. With the term of adventure pedagogy and adventure education in our literature we meet only sporadically. In foreign literature, we can find chapters dealing with basic terms of adventure pedagogy, such as adventure education, adventure-based learning programme, adventure activities, adventure games and projects, general adventure activities and sports and etc. (Mareš, Gavora, 1999; Průcha, J., Walterová, E., Mareš, J., 2003).

To pre-gradual teachers of science subjects during their pre-gradual preparation are offered possibilities of usage elements of experiential or adventure education (pedagogy) through microteaching within subjects as Classroom management, General pedagogy and methodology, and selected subjects pedagogy.

Proposed and realised didactic games by students fulfil all requirements on the effectiveness of teaching process, to which they are preparing. By microteaching we concentrate on development and formation teaching competencies. With adventure or experiential education we are also dealing within a grant projects VVGS–39/09-10 „Elements of adventure education in educational behaviour of a classroom teacher“, APVV 0088-07 „Micro-educative analysis in pre-gradual teachers' preparation of the science subjects as a tool of increasing of effectiveness competency-based education“, grant project VEGA 1/0193/08 „Micro-educative analysis in competence education of science subjects pedagogues“ and KEGA 034-014UPJŠ-4/2010 „Effectiveness of educational behaviour of a classroom teacher by implementation of experiential education elements during after-school activities with pupils“.

The aim of the research in projects is to contribute with microteaching and micro-educative analysis to the effectiveness of pre-gradual preparation of science subject teachers by applying elements of experiential and adventure education.

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# History and Philosophy of Chemistry in Secondary Schools: Representing Authentic Historical and Philosophical Ideas through Simulated Newspapers

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**Background, framework and purpose:** The 30 month, 8 country, EU History and Philosophy in Science Teaching (HIPST) project was established in February 2008. Höttecke (2009) in his ESERA paper about HIPST acknowledged the importance of History and Philosophy of Science towards school teaching, and the dearth of research about and curriculum resources for HPS teaching in schools. Williams (2002) surveyed the history of science in textbooks in England in 1999, following the integration of science into the mainstream school science curriculum, finding that examples were of the heroes and villains type, and failed to give a humanistic approach to science. The project aims to present historical and philosophical contexts for embedding usual science topics, such as temperature, acidity, chemical formulae and equations. The work in this paper has aimed to interpret original historical documents and philosophical positions in language appropriate to the level of the learners, while remaining as authentic as possible. It has been subject to classroom trial and to scrutiny by practising class teachers.

**Methods:** A web site for each topic was constructed to collect original published work and authentic papers by some of the scientists involved. This information was presented orally to the classes (Year 7 for Temperature, Acidity; Year 10 for Chemical Formulae and Chemical Equations). Further to this, short newspapers interpreting the original information and including pupil-generated material were prepared for dissemination in class. Full information on the Temperature Study will be provided in the presentation, with supplementary material from the other topics. Information was collected through analysis of learning recorded by the pupils, through discussion with the teachers and pupils.

**Results:** The information collected suggested

- a. It is possible to interpret for Year 7 pupils original historical information, while retaining a sense of authenticity
- b. It is possible to create explanations of some fundamental science philosophical ideas that the majority of Year 7 pupils can understand.
- c. Year 7 pupils are motivated by the human stories of famous scientists.

**Conclusion:** Teacher-written newspapers can be successfully used to teach History and Philosophy of Science to Year 7 learners.

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## **Pre-service science teachers' views about sustainable development**

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Keywords: sustainable development; science education teachers; sustainable living, environmental education, Turkey.

In our time, the most important problem is sustainability. Science education for sustainable living is a new area of education that requires exploring teaching and learning models. But in our country there is some deficiencies about these subject. There are merely researches about the meaning of sustainable development in the minds of teachers. Therefore, we aimed to reveal the views of pre-service science teachers related to the sustainable development in this study. 49 third grade pre-service teachers (31 male, 18 female) studying in Gazi University Faculty of Education Science Education Program participated in the research. The pre-service science teachers were educated about sustainable living through active learning methods over a 5-week period. The pre-service science teachers were asked to define the sustainable development concept and express their views before and after the education about the sustainable life. Data we obtained was explained by means of content analysis qualitatively. According to the findings of the research; while the definition of the sustainable development in the minds of the pre-service science teachers had been more narrow and limited before the research, it was observed that number of the words that they put into each category increased after the studies related to the sustainable life (social and cultural views, the principles of the sustainable development etc.). It was seen that their vision developed and contents of the sustainable development concept got richer. At the end of the study, some suggestions were made to run seminar and giving lessons about sustainable living in education faculties may be effective about that. Carrying out this study for all students of the faculty of education may create a larger sample that may produce a larger perspective of views and suggestions that could contribute to the educational world.



## **Selected topics in education of physical and social geography emphasised with respect to the climate change**

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Climate change and related aspects are of concern even for the youngest generation. This fact may be a good starting point to emphasise several related aspects of science and of society, or, as we call them, natural and social geography. Many aspects were just dead materials to learn without this enhanced attention and concern.

The Intergovernmental Panel on Climate Change (IPCC) grouped these aspects into three branches in its last two Assessment Reports (2001, 2007). They are the Scientific Basis; the Impacts and Adaptation; and the Mitigation of the Changes. The first group and the first term of the second one provide opportunity to focus the attention of pupils towards a few problems of physical geography. The second part of the second term and the third one help us to tackle social geography.

The allotted time and space for the paper are enough to select a few key issues, and to join the climate-specific problems with the immanent chapters of geography. The three topics, being treated in the IPCC problem-groups, are as follows:

(1.) Natural and anthropogenic factors of climate including their space and time scales; Spatial distribution of the observed and of projected changes, as compared to such traditional terms as geographical zonality, continentality and seasonality; The role of thermal expansion, ice-melting and other factors in the experienced sea-level rise.

(2) Impacts of sea-level rise on islands, sea-shores and marine environment; Vulnerability of special topographic forms (basins, mountains, permafrost, etc.); Impacts, adaptation challenges and interactions with non-climatic problems in the cities.

(3) Origin of climate forcing air pollution and their cross-cutting effects with other problems of the environment; Economical and societal factors to decrease the global greenhouse gas emission; Inter-relations of climate change, sustainability and the Millennium Targets for Mankind.

Though these topics of geography involve the corresponding professional information, in the paper we would not overload our teacher-mates with the technical details. The aim is rather to focus on the pedagogical and methodological moments of the highlighted aspects.

## Teaching of Chemistry - modernity or history?

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Chemical content during the education process at school, is transmitted not only by teachers of chemistry, but also by teachers of other subjects, particularly physics, biology and geography. Chemistry in the twentieth century, developed very intensively. Research and reflection gave rise to new views on the structure of matter.

Currently in school textbooks we do not find full mirroring of current views on the structure of matter. During the education of chemistry process there are often transmitted chemical theories and ideas even older than half a century. Examples of such views are: the Rutherford-Bohr model of atom, the theory of acids and bases by Arrhenius, or the law of definite proportions. Therefore, in many cases, the pupil is not familiarized with the modern picture of the structure of matter but only with the view as scientists had imagined it for over half a century ago, and sometimes even more than 100 years. Therefore two open questions remain: why in frames of the lessons do we teach the history of chemistry and we call it contemporary chemistry, and secondly, do we have to learn the history of chemistry, instead of modern chemistry?

### Adjustment of the offer of subject teacher training to the model of the 21<sup>st</sup> century teacher

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The article presents the results of an analysis of internet websites of selected teacher training centres in terms of course offers for life science teachers.

The aim of the review is estimation of the applicability of the courses in improving teachers' skills in teaching their subjects in the reformed school. We compared the subject matter, number of hours, duration and form of the training offered. We also attempted at answering the question whether the training offer will provide teachers with skills to teach pupils key competence such as:

- organisation and evaluation of learning,
- efficient communication in various situations,
- effective team cooperation,
- creative problem solving,
- effective use of information technology.





# Beyond the equal treatment of the didactically unequal in high school chemistry classes: a step towards the context-dependent learning environment (a case study)

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Key words: high school chemistry, context-dependent learning environment

**Background, framework and purpose:** At the outset we considered the following theoretical framework. (1) According to Hodson (1998), students can use chemistry knowledge properly as they come to understand it; to achieve this, learning should be embedded in authentic and meaningful activity. (2) According to Kolb's learning style inventory, the traditional problem-solving approach calls for four ways of cognition – active experimentation, concrete experience, reflective observation and abstract conceptualisation. This is the reason why the approach cannot lead to achieving excellence by all students since integration of all four specialised ways occurs rarely (Garnett 2005). (3) From the neurolinguistic approach to learning, to shape concepts and to truly understand them, it is essential to make one's own mind maps, therefore students should be encouraged to look for information and draw conclusions themselves, to draft their ideas and create a personal model. Teachers simply assist students by being in interaction with them and giving them an immediate feedback (Požek-Novak 2005). For the case study, environmental topic with a strong high school chemistry background was chosen as a context-dependent learning environment. The study was carried out in 2006/2007. It involved two groups of 15 high school chemistry students (17 years old) and the same teacher. The average grade in both groups was approximately the same (3,5).

**Methodology:** During the case study the first group of students was taught exclusively in a traditional problem-solving and teacher-centred way. The second group acquired knowledge partly in a traditional problem-solving and teacher-centred approach and partly in student centered approach where the students' building of knowledge was stressed. At the end of the unit, there was a test of the key chemistry notions described in the high school chemistry syllabus as pertaining to the topic. The test used contained an example of every Bloom taxonomic level; each question pertained to the content prescribed by the syllabus. Within the evaluation framework, the last question went partly beyond the content objectives of the syllabus since it transposed the knowledge gained to environmental problems.

**Results, conclusions and implications:** The comparison between both case-study groups confirms the premise that the shift from teacher-centred classes to student-centred classes and upgrading the traditional problem-solving approach by giving a greater role to students in recognising the patterns and building knowledge is what leads to a more global understanding of the basic chemistry notions. This was clearly demonstrated by a better quality of answers given by most students (at the test). Therefore, students should understand procedural knowledge to the extent that they can use it themselves and evaluate whether it has been used appropriately.

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# The assessment of different age students' comprehension about environmental chemical processes in Latvia

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Keywords: chemistry education, environmental processes, different age group students

**Introduction:** Today, when anthropogenic load on the planet Earth have reached unprecedented size, part of the society use to blame chemistry in deterioration of surrounding environmental quality, namely, the pollution caused by chemical industry. This wrong opinion is possibly caused by insufficient knowledge about chemistry and inaccurate comprehension of environmental processes. The environment quality deterioration process is equally connected both with chemical industry and properties of substances involved in environmental processes, and with human activities that do not comply with sustainable development. The formation of environmental comprehension forms as a lifelong education that every individual learns before his school years continually enlarges and increases during learning process and his everyday life. The aim of our research was to ascertain how well students of different age understand and interpret chemical processes taking place in environment.

**Methodology:** The research examines experience of Latvian and other scientists in clarification of differences in young generation's perception and attitude towards environment. During research, an appropriate test of knowledge in chemistry was developed. This test includes issues that are observed in different Latvian chemistry's and environmental subject's curriculums, as well as in mass media displaying environmental problems. The suitability of the test for students auditory was determined. In pursuance of the test were involved students of different age that have been learning chemistry in different educational institutions.

Respondent group No. 1 – primary school 9th grade students (age 14 – 15).

Respondent group No. 2 – secondary school 10th grade students (age 16 – 17).

Respondent group No. 3 – secondary school 12th grade students (age 18 – 19).

Respondent group No. 4 – vocational secondary school first and second year students (age 16 – 18)

Methods of statistical data processing that are available in MS Excel and SPSS where used for analysis of results acquired from the test. A coefficient of the test reliability ( $r = 0.74$ ) shows that the reliability of elaborated test is high enough.

## Results:

- Essential difference in the knowledge and comprehension was observed in all groups of respondents (dispersion of results in the interval from 0.20 to 0.95).

- The level of knowledge differs in all respondent groups; however the percentage of right answers is higher for elder students (No. 3).

- Respondent of group No. 4 (students of vocational secondary schools) in general showed somewhat weaker knowledge than students of comprehensive schools at the same age.

## Conclusions:

1. The level of knowledge and comprehension about chemical processes happening in environment substantially differs in every group of respondents.
2. Overall, better comprehension showed elder students of comprehensive secondary schools (Group No. 3), it could be explained with fact, that they have obtained deeper knowledge in chemistry.
3. Students in age from 17 to 19 better orientate themselves in problems that are discussed in mass media, not only in curriculums. This fact confirms the necessity for the reassessment and restructuring of educational program's content.

## **Chemical aspects of threats and environmental protection in the investigation of school children and students' ecological awareness**

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The work describes environmental (ecological) education in Poland. Environmental contents can be included in the programmes of individual subjects. The work presents various possibilities of implementation of these problems within the framework of chemistry teaching. Furthermore, an idea of realization of environmental education in high school with chemistry specialization has been presented. Regularly accomplished environmental education leads to the raise of ecological awareness of school children and students. Nowadays, many countries pay a lot of attention to the development of ecological awareness among their citizens. The inquiries are carried out among different social groups. In this work the results of such inquiries among school children and students are presented. During the inquiries a special attention has been put on chemical aspects of threats and on environmental protection.

# Integrating a Virtual Learning Environment into a Scientific Communication Course

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Keywords: VLE, higher education, chemistry.

**Background, framework and purpose:** Computers have been prevalent for many years in the physical sciences in that they are used in instrumentation and in data analysis within undergraduate courses, and students have become adept in their usage (Lovatt et al., 2007). In Brazil, the Curricular Directions for Undergraduate Chemistry Courses have proposed the development of new ICT pedagogy for the improvement of teaching within higher education (Zucco et al., 1999). There is a plethora of ICT resources and products available for use within the physical sciences. These resources include online lecture notes and tutorials, Virtual Learning Environments (VLEs e.g. WebCT, Blackboard, Moodle), and simulations. The aim of this work is to investigate the use and acceptance of the VLE named Cursos on-Line (CoL) developed by University of São Paulo, Brazil. The VLE was adapted to be applied in a scientific communication course offered to freshman students in an undergraduate chemistry course in a Brazilian university.

**Methods:** The use and acceptance of the VLE by the students were investigated based on the concepts of Technology Acceptance Model (Davis et al., 1989). The research population consisted of 61 students. Data were collected from questionnaires completed by the students at the end of the course. The questionnaire used for data collection contained scales to measure the various constructs depicted in the research model.

**Results:** Along the semester, the VLE was accessed 989 times and a total of 705 messages were posted on the forum. This study found that students' acceptance of the VLE is significantly associated with the provision of: lecture notes, links to the web that provide access to the major electronic databases, online forum, message system, glossary, chat, and a database of homework questions.

**Conclusions and implications:** The VLE spread communication and teaching opportunities in the course. The appeal of the user interface, the presence of appropriate search options and the availability of sufficient relevant information are critical factors for the VLE's acceptance.

The diagrammatic representation of the variables identified in this study provides a useful reference point for those educators contemplating the implementation of a VLE.

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# Development and Application of a Tool Designed to Evaluate Undergraduate Chemistry Students' Scientific Writing

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Key words: scientific writing, higher education, chemistry.

**Background, framework and purpose:** In recent years, educators have increasingly emphasized the great importance of the ability to understand and use scientific language (Lemke, 1990). Therefore, science education has to enable students to develop this ability. To achieve this goal, it is necessary to highlight the integration of (scientific) language aspects in science class. In this context, the aim of this study is to present a tool designed to evaluate undergraduate chemistry students' scientific writing: Characterization Map of Scientific Text. This tool was applied in an organic chemistry course offered to undergraduate students in a Brazilian university.

**Methods:** The Characterization Map is mainly based on Bruno Latour's Science in Action (Latour, 1987). Latour's writing about science in action takes it for granted that science is a textual enterprise, and that narrative is an essential moment of the work of science. The Map has structural and rhetorical aspects of the scientific writing, as well as textual elements related to these aspects.

The Characterization Map was applied to analyze a writing task designed to increase students' awareness of chemistry-specific practices. This task required twenty students to write a text in the format of a scientific article. The following topics were discussed in the articles: acid-base reactions; solubility, synthesis, and extraction of organic compounds.

**Results:** Based on the use of the Characterization Map it was possible to identify structural and rhetorical elements within the articles written by the students. They were able to perceive the rhetorical principles underlying the scientific style and learn conventions of writing in the sciences, such as maintaining objectivity, avoiding jargon but using terminology, using the passive voice appropriately, handling equations, and integrating illustrations into the texts.

The texts included traditional sections (abstract, introduction, methods, results, discussion, literature cited) and for the experimental work sufficient detail about materials and methods were given. In addition, assertive sentences were made.

**Conclusions and implications:** Results show promise for the Characterization Map as a methodological tool for the recognition of structural and rhetorical elements of scientific articles. Therefore, it can be used to improve chemistry students' scientific writing.

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# Knowledge of the nomenclature of inorganic compounds of medical students and technical

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Key words: nomenclature, inorganic chemistry, IUPAC, PTChem, students

In 1990, International Union of Pure and Applied Chemistry ((IUPAC) has adopted new guidelines for a uniform nomenclature of inorganic compounds. In Poland, the IUPAC recommendations for the Polish conditions, the Commission has adapted the nomenclature of language Polish Chemical Society. Since then, the chemistry teachers were obliged to implement these changes while teaching the subject at school. Unfortunately, not all these recommendations applied, and a few years, students learned and used the 'old', already an incorrect nomenclature.

It was decided to check and compare, as presented in today's knowledge of medical students and technology in this field. Does the choice of field of study has an impact on the knowledge of the nomenclature of inorganic compounds? Does the choice of chemistry as a matriculation course and evaluation of this subject at the end of the school show a correlation with the knowledge of names?

Used for testing the questionnaire survey in which students were asked to name or give the designs selected inorganic compounds.

## Didactic tool for the learning of the periodic table

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Keywords: microscale, didactic tool, periodic trends, chemical education

**Background and objective:** The periodic behavior of the elements and its utility in the prediction and extrapolation of properties through them is an indispensable tool in the education and the learning of basic concepts of chemistry. Therefore, a plastic model (a blister) in PETG of nutrition grade was designed. This blister (Patent pending) measures 29,5 cm in length per 18,6 of wide one and half centimeter of height. Each blister it has 118 cavities of cm of diameter and with a depth of 0,5 cm, which are distributed according to the position of the elements in the present periodic table.

This didactic material has turned out to be very useful to visualize properties of the elements using economic material of different colors (sweet, chewing gum, marbles, small bullets, etc), or adapting test tubes each of 3 cm in length and 1 cm in diameter that can be introduced in the orifices of blister.

**Methods:** Some of the following, are blister described applications, although these are not exhaustive and the application will depend on the creativity of the users.

- Acid-base character of oxides.
- Redox Trends
- Countries that have contributed to the discovery of the elements.
- Metallic elements, non-metal and metalloids
- Atomic radii
- Abundance
- Methods of extraction
- Electronegativity
- Physical state
- Uses
- Solubilities

**Results, conclusions and implications:** This didactic material allows the discussion of a great number of properties that vary periodically and also allows to locate the position of the elements and to learn nomenclature. The design allows experimental practice with simple reactions on microscale, lowering costs and diminishing risks. In addition, adapting test tubes is still made but to each user's versatile and adaptable necessities and resources.

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# Obtaining and identifying inorganic gases microscale techniques

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Keywords: Microscale, inorganic chemistry, laboratory, gases obtention

**Background and objective:** Considering that one of the most important challenges in the development and teaching of Inorganic Chemistry requires a suitable design for a laboratory program which, of course, includes the safe and proper handling of gases, both in their production as well as in their properties' identification, a protocol was designed that allows obtaining and identifying five gases (ammonia, chlorine, sulfur dioxide, nitrogen dioxide and carbon dioxide). This protocol was implemented first in the National Olympiad of Chemistry held in Campeche, Cam. State in Mexico and served as an important element in the discrimination and selection of the 16 students who will participate in the International and Ibero-American Olympiad to be held this year in the UK and Cuba respectively. The application of the protocol was tested to 57 top high school students from the 32 states that comprise the United Mexican States (6 students from each state). In this paper, the obtained results are presented.

**Methods:** This same protocol was applied in two laboratory groups of students in a descriptive Inorganic Chemistry Course, within existing curricula. The subject is taught in the third semester for all undergraduate degrees offered in the Faculty of Chemistry. The analysis of the results will be presented.

**Results:** The design of this experience implies the following:

1. Election to obtain the five gases: Ammonia, chlorine, sulfur dioxide, nitrogen dioxide and carbon dioxide.
2. Selection of the reagents to obtain the gases, prioritizing those in which the use of a solid and a liquid and where the reactions would be carried out at room temperature
3. Bibliographic research for the reactions in the identification of the gas.
4. Analysis of options that enabled to distinguish among them.
5. Selection of the 12 best options for identification involving different types of reactions (Acid-base, redox, precipitation and formation of complexes).
6. Preliminary tests to determine concentrations of the solutions selected.
7. Design of the preliminary protocol and validation thereof.
8. Experimental work to establish operating conditions
9. Changes to the protocol based on obtained experimental results.
10. Preparation of the equipment and reagents for the application to 60 exams with five different options.

Students were presented with the task problem of obtaining and discriminating among five gases by using 12 different reagents and they were advised to use a disposable Petri dish with a hole in the center (to introduce the liquid reagent); drops of each of the reagents were placed nearby to enable them to identify the gas once generated in the closed system.



For the assessment of the performance test, a total of 100 points were allocated, divided as follows:

- 30 points to the filling out of the initial table (hypothesis)
- 30 points to the observations of the properties
- 10 points for the identification of the gas
- 20 points for the equations representing the reactions that allowed them to identify the gas (5 points each)
- 10 points for the equations formulated to obtain the different gases (2 points each).

**Conclusions and implications:** From the standpoint of economics and according to ecological rules, the experiment was successful because the reagent consumption was minimum (4 mL) and practically no waste was generated.

The preliminary results have allowed teachers to assess the main difficulties presented by students while addressing a practical problem and evaluating their lack of ability to collect and analyze the experimental data obtained.

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## Student Interpretations of Number in Solutions Chemistry

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A number without a context in chemistry is useless because of all of these possible uses of number. In the same vein, because of all of the different possibilities for numbers in chemistry, students may have different interpretations of number for each possibility. Number is an essential component to the teaching of chemistry and students are often tested on their algorithmic skills. However, as studies suggest, students can perform algorithmically and have no understanding of the concept being tested (Beal & Prescott 1994; Dori & Hameiri, 2003; Nakhleh, 1993; Nakhleh & Mitchell, 1993; Zoller et al 1995). Given that numbers represent a variety of things in chemistry, it is possible that this contributes to the memorization of numbers rather than conceptualization

of them. Specifically my study addresses the following research questions: What are students' interpretations of: number in solutions chemistry problems involving molarity, number with respect to molarity and volume, significant figures in solutions chemistry, and number in the balancing of equations in solutions chemistry?

Data will be collected from incoming university students who have taken a chemistry placement exam using stratified sampling. Student interpretations of number in the various situations will be collected through specific tasks involving molarity, volume, significant figures, and balancing equations. Results from the pilot study include: 1) One student thought that 0.05M is 5% less moles than 0.10M; 2) Several students think that 0.05M means that all three bottles have the same amount of moles of calcium chloride in each bottle with just more space between the molecules as the volume increases; 3) One student indicated that the more significant figures means that more of it was important because 0.10 has 2 significant figures and 0.05 has 1; 4) Students mention ions and oxidation numbers while balancing equations, but do not draw dissociated ions at the molecular level. More data needs to be collected with the incoming students in the Spring 2010. Implications of this study include outcomes in research, instruction and standards. A better understanding of student interpretations of number could: inform other research studies, remove tacit use of number in current standards and create new standards concerning number in solutions chemistry, lead to better instruction using scientific vocabulary connecting it to the physical world for comparison, make teachers aware of possible gaps between their own interpretations of number and those held by their students, and lead to a more conceptual teaching of the balancing of equations.

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## **Graphical representation of data in the form of graph showing the relationship between variables - an analysis of student errors.**

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Within standard describing examination requirements of the biology is, among others, standard which represents the student's ability to process information and construct graphs. Tasks classified in the area of this standards appears in the examination sheets each year, and it would seem that those kind of tasks should no longer cause any problems for students. However, we can still observe a group of students that have problems with the correct solution. In 2009, the facility factor for the task nr 19 screening discussed skills was 0.72 in the district of Poznan OKE. 300 randomly selected works from the matriculation examinations on biology taken at the advanced level in 2009 by students from high schools was analyzed. The answers given by students have been subject to a qualitative analysis on the basis of which we can identify the fundamental errors made by students and search for at least some reasons that may explain these errors.

### **Steps of a scientific experiment under a magnifying glass.**

#### **Analysis of the answers given by students to selected tasks illustrating the different stages of a scientific experiment at the matriculation examination in biology in 2009.**

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PISA survey conducted in 2006 focused mainly on mathematical and science skills of pupils. According to this survey, polish students are having problems with skills such as planning experiments and using methods that are typical to scientific experiment. The matriculation examination on biology in 2009 at the advanced level contained tasks that were viewing skills and knowledge of the different stages of a scientific experiment. Task nr 2 was verifying skill of planning experiment, task nr 5 was supposed to check the ability of drawing conclusions, task nr 11 - putting the research hypothesis and nr 13 - formulation of research problem. We analyzed 300 randomly selected works from the matriculation examinations on biology taken at the advanced level in 2009. The answers given by students have been subject to a qualitative analysis on the basis of which we can identify the fundamental errors made by students and search for at least some reasons that may explain these errors..

## Chemical experiment in the process of developing key competences

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Numerous curricular changes are running within the current educational system. Besides, the changes aim at “supporting complex approaches towards realization of learning content, including the appropriate linking, and it expects both selecting various learning procedures, methods and forms of instruction, and applying supportive measures adequate to individual pupil’s needs.”

It means that support of the process of instruction (mainly the material support) must be discovered in various forms of innovations of traditional learning support. Under this term the new views on experimental activities corresponding to substantial heuristics enhancement chemical process interpreted by the given experiment or by several experiments. This change in views provides a more complex precondition towards building key competences, which are defined in the school educational programmes. The above mentioned innovations influence substantially the characteristics of the interpreted experiments. Instead of single object-different experiments the emphasize is paid to sets of object-binded experiments which are not intended to description only, but which discover principles of the studied action. This strategy is then reflected in the characteristics of communication between both participants of the learning process, mainly in teacher’s questions. It is generally accepted that questions of the HOW type accompany lower-level mind procedures and check simple recalling of knowledge, while discussion-encouraging questions leading pupils to thinking are of the WHY type, i.e. of higher level from the educational-psychological view. Thus the problem of asking questions often becomes the main topic of the didactic research because questioning, i.e. the type of the used question) provides information on the quality of the directed process of cognition.

Thanks to the fact that during the study strong attention is paid to the problem of interpreting the chemical experiment and communication, we were interested in to what extent it is reflected in young teachers’ competences. The research was run using the analysis of video-recorded chemistry lessons during the training period of young teachers. The collected data provided information not only on the frequency of experimental activities, but also on the process of experiment interpretation. The process and discussion of the received results are the main topic of the paper.



# School based in-service education as a form of professional development science subject teachers

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During the last years, science subject teachers in Poland have faced new challenges as a result of radical changes in the organization of the educational system and the necessity to adapt science teaching to the requirements of modern school. Changes also take place in the system developing teachers' professional skills. Science subject teaching is more and more affected by making use of the world achievement in this field as well as by the necessity of adjusting educational standards to the requirements resulting from Polish membership in the EU (Osborne & Dillon, 2008).

Professional development possibilities of teachers in Poland are not satisfactory taking into account both needs resulting from the above described situation and the effects following from them (TALIS, 2009). There disappear some hitherto educational forms like collaboration with professional advisers or so called "self – educational teachers teams". Teachers' participation in various courses is largely due to the fact that a formal certificate of a course accomplishment is necessary to obtain further professional promotion. On the other hand, it does not change much or anything in teachers' everyday work. Therefore it is necessary to search for new forms of in-service education science teachers like the school based in-service education (van Lakerveld & Nentwig, 1996).

The accomplishment of the project CROSSNET created possibility to conduct the case study the aims of which was practical testing of such form of in-service science teachers education (Janiuk, Samonek-Miciuk & Lang, 2007). According to the assumptions of the project the teams from 6 Junior Secondary Schools with at least 3 teachers of different science subjects (biology, chemistry, geography or physics) took part in the case study. Each team was to plan and accomplish tasks improving science subject teaching in their schools. They had to include accomplishment of intersubject contents related to e.g. environmental education, health education etc. The project method that accomplishes interdisciplinary character contents for their integration and requires effective collaboration of teachers of different subjects proved to be the best.

Analysis of the data obtained from questionnaires, reports, as well as other information gathered in the course of project accomplishment by the coordinators allows to draw the conclusion that application of school based in-service education for developing the teachers' professional skills allows to cross many boundaries, particularly related to integrated teaching of science. It supports and intensifies teachers' collaboration within school and new skills obtained by them are useful in everyday school practice.

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## **Analyses Methodologic about the pedagogy of the European education higher area (E.E.S.)**

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TALLER: Universalization of education.

European Union policy focus to the globalization of higher education colleges in its 27 states. The next course will be mandatory in all European universities conducting some innovative teaching methods very different from those that traditionally have been used so far.

The new learning concepts obligate the teachers to reject the traditional class as the only way to teach and reinforce it with pedagogical aids that allow students to reach a better understanding of the different subjects as well as a practical study of it, always supervised by a teacher.

The basic concept introduced is the ongoing work by students towards the subject, with continuous partial evaluations of the works presented as well as their knowledge and attitudes for each subject.

The evaluation of the student will therefore be permanent and continuous. It will be very taken into account their willingness to work, deliveries of practices, their attendance, the interest shown, its practice curriculum, attendance to seminars ...

The traditional final exam will be a purely procedural additional rating not exceeding 50% of the final evaluation of the whole subject. even for many students, as considered by the teacher, many of them will not have to take the final exam.

The new pedagogical concepts include a new way to teach the student closer, with more learning opportunities by themselves, and ultimately allowing them a greater understanding of any subject as well as a decrease of the current failure in universities in Spain, which are offering a dramatic estimation of desertions and failures.

The paper describes the new restructuring implemented in a practical way of teaching various subjects in the Higher Polytechnic School.



# “Virtual Science Museums as a Teaching Strategy”

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Keywords: Virtual Museum, Teaching Strategy, Cultural-Heritage

**Background:** This is a proposal related to a work in progress. Virtual museums of science proliferate in the Internet, thus becoming communication and teaching spaces for all kinds of publics. Many virtual museums nowadays constitute true learning environments in which—in a special manner— teachers can find a new way to bring heritage closer to children and youth. The main aim of this paper is analysing the role virtual science museums may play as a resource for the elaboration of didactic activities within the frame of the classroom. It shall analyse teaching resources and strategies, elaborated educative science materials and interaction systems employed by science museums to generate new knowledge and new educational values.

**Research:** The main objectives of the research are:

- To analyze the different types of virtual museums (VM). Can we talk about only one kind of virtual museums?
- To identify the main strategies that virtual museums use to enhance learning, specially to students from the formal education.
- To identify the main resources and instruments that VM use to enhance learning.
- To analyze what kind of resources and strategies are more useful for students and teachers in they day life at schools to enhance learning.
- To know how the students and teachers really uses the VM in they day life at schools (specially in sciences).

For the research, we analyzed 17 different virtual science museums and we focused on:

- Specially place on the web site called “didactic”, “learning”, “education”...
- Programs for schools (from 6 to 16 years).
- Educational resources for teachers like lessons, pedagogical orientations, didactics sheets, reproduction of original documents...
- On-line learning activities
- Off-line learning activities
- On-line interactive activities through social resources (facebook, twitter, flickr, blogs, etc.).

**Results and first conclusions:** The main results and conclusions on that point are:

- The didactical service of a virtual science museum is not always linked with “education”.
- The activities are “still” linked to a real museum.
- The educational activities are extremely content focused.
- The activities related to social resources/applications (like web 2.0) are focused on “explaining” the museum.

One of the most important implications is the important role that pedagogical methodology can have in the process of creating new activities and educational on-line materials in virtual science museums. Science museums as a procedural learning environment.

# Science museums as a procedural learning environment

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Keywords: Education in science museums, procedural contents, educational materials

This proposal presents some of the results obtained from research into the treatment of procedural contents in relation to museums based on a detailed study of the science museum's own didactic proposals, analysis of official curriculum documentation, the experiences of teachers who have participated in educational activities within science museums, and the examination of the didactic materials developed at science museum institutions.

**Background:** Museum institutions have the possibility of offering spaces for the treatment of procedural contents, enabling methods and procedures pertaining to the discipline of each institution to be put into practice. That is, the creation of procedural contents in a science or history museum can be considered as a type of laboratory in which to study all that directly or indirectly affects the creation and learning of scientific and historical knowledge. Despite the possibilities that the museum may have as a procedural space, this is not, in itself, sufficient either for the students or the institution. It is clear that the consideration of museums as procedural spaces should not be solely confined to the use that can be made of them by schools alone, our main interest is focused on these visitors as these users need to learn the procedures associated with certain disciplines as one of the basic objectives of their compulsory education. From our perspective, one of the collectives that is most able to benefit from museums as procedural spaces is the school collective.

**Methods - Research hypothesis:** Teachers, pupils and museum educational staff make very limited use of the museum's didactic proposals in Catalonia (Spain). This use involves dealing mainly with conceptual contents and avoiding working on procedural contents relating to the analysis methods of the museum's particular disciplines. The above forms a general theoretical framework on which to prepare instruments to obtain the data to apply to three basic subjects of analysis:

Firstly, the agents directly or indirectly related to the use of didactic proposals within the framework of museums for the learning of procedural contents (teachers and pupils - Only the results obtained from teachers appear in this proposal).

Secondly, the design of curricula and their approach to the term "procedural contents".

Thirdly and specifically, the didactic materials presented by the museum, particularly in relation to procedural contents.

**Results, conclusions and implications:** The research data analysis tells us the contents of a conceptual nature are the more common ones for museum educational activities. Even if there was a gradual introduction of procedural contents in the museum environment, it is evident that we are still far from achieving some kind of balance in approaches. The main body of theory for the subject field on which each and every museum is based has its own methods and techniques. It being available to the public does not always correspond to the logic of a curriculum based on conceptual, procedural and attitudinal content. If a museum has decided to include such vocabulary, this is possibly due to the necessity to adapt to the demands of educational groups.



# ОСОБЕННОСТИ ЭКОЛОГИЧЕСКОЙ ПОДГОТОВКИ БУДУЩИХ ПЕДАГОГОВ

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Ключевые слова: экологическая культура, экологическая подготовка, педагог

Введение. Проблема подготовки экологически грамотных учителей является актуальной на современном этапе развития экологического кризиса. Выявлено, что современная экологическая подготовка учителя должна строиться с учетом: социального заказа общества; фундаментальных педагогических и экологических исследований, технологии реализации знаний методологических основ в практике в процессе последовательного осмысления природоохранных традиций и новаторства; конкретно-исторического анализа экологических процессов, с учетом интегративных процессов, моделирования и прогнозирования состояния окружающей среды, теоретического проектирования эколого-педагогического аспекта воспитания, обучения и образования; творческого подхода к изучению приоритетных и альтернативных направлений развития экологии как науки на основе широкого привлечения студентов к самостоятельной научно-исследовательской работе с использованием обязательной экспериментальной технологии, реализации теоретических основ на практике; фундаментализации экологического образования на основе прогностического и пропедевтического построения учебно-воспитательного процесса по экологии, обращение особого внимания на осуществление эколого-практической подготовки; индивидуально-творческого подхода к подготовке учителя-эколога на основе повышения личного уровня овладения специальностью и формирования творческой индивидуальности непосредственно в высшем учебном заведении, развитие эколого-педагогических взглядов, экологического мышления, технологии экологической деятельности [1; 2].

Цель данного исследования – разработка системы экологической профессионально-педагогической подготовки будущего учителя. Для достижения поставленной цели использованы следующие методы: теоретические (анализ и обобщение философской, психолого-педагогической, научно-методической литературы) и эмпирические (наблюдение, беседа, педагогический эксперимент, проектирование и моделирование).

Результаты и обсуждение. Установлено, что центральной задачей экологической подготовки учителя является формирование функционального поведения, то есть сочетание учительской подготовки и приобретение специальных экологических умений для будущей работы. Основной целью экологической подготовки студентов выступает формирование системы экологических убеждений личности, которые определяют линию социального поведения в области охраны окружающей среды, рационального использования природных ресурсов, воспитания молодежи. Готовность будущего учителя к экологическому образованию представляет особое психологическое состояние, целостность которого взаимодополняется и взаимообуславливается действиями интеллектуального, мотивационного и операционного компонентов в структуре личности [3]. Выявлены смысловые характеристики такого состояния: понимание личностью сути экологических проблем, их природы и источников развития; знания биологии, географии и законов развития биологических и географических объектов; понимания роли и возможности экологического образования в решении экологических проблем; наличие потребности принимать участие в охране и защите окружающей среды; стремление к организации

и проведению природоохранных мероприятий; наличие моральной ответственности в отношениях с природой, умение проводить просветительскую работу в области защиты и охраны окружающей среды; умение передавать знания в области экологии, умение практически организовывать работу по наблюдению и предупреждению негативных экологических явлений в природе.

В рамках избранного подхода экологическая подготовка будущих учителей рассматривается нами как процесс становления и развития профессиональной индивидуальности [3]. Поэтому главной особенностью экологической подготовки провозглашается психологическая зрелость будущих учителей. Перед учителем современной школы стоит серьезная задача – выработать у воспитанников чувство ответственности за судьбу окружающей среды, научить оценивать роль и место человека в биосфере, привить им устойчивые навыки природоохранной работы, развить способность критически оценивать действия человека и, прежде всего, собственные с позиции экологии и интересов общества. Следующей особенностью, характеризующей подготовку учителя, является экологическое самосознание и развитие профессиональных интересов. Готовность учителя к реализации задач экологического образования определяется духовными ценностями, которые детерминируют программу жизненных и профессиональных задач.

**Заключение.** В исследовании разработана и внедрена система экологической профессионально-педагогической подготовки будущего учителя, которая обеспечивается следующими действиями: 1) накопление теоретических экологических знаний, которые обеспечат выход в практику; 2) формирование экологического мышления предусматривает восприятие определенных экологических мировоззренческих принципов, которые опираются на ценностные природоохранные ориентиры, моральные и этические нормы поведения в природе, эстетические идеалы; 3) воспитание экологического сознания, которое включает понимание доминирования природных благ над созданными материальными благами, экономное отношение к природным ресурсам; 4) формирование экологического мировоззрения как средства определения позиции человека в социальной, экологической, научно-теоретической, философской, моральной и эстетической ориентации; 5) обретение мастерства, которое проявляется высоким уровнем самоотдачи учителя, экологическим кругозором; 6) обеспечение гармоничного сочетания экологического мировоззрения и способности к самообразованию, творчеству, инновационной деятельности в целях становления экологической культуры учителя.

Показано, что критериями сформированности активной экологической позиции педагога выступают смысловые характеристики отношения личности к природе: активность, направленность, адекватность. Доказано, что экологическая подготовка студентов значительно повысится при условиях: поэтапного формирования активной экологической позиции (осознание роли человека в природе; оценки и контроля экологической деятельности для определения выбора личностного отношения к природе); использование специальных проблемных ситуаций и привлечение студентов к исследовательской, творческой, природоохранной и пропагандистской работе.

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# Bicarbonate of soda as curricular and vocational agent

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Keywords: soda, secondary vocational education, role play method, differentiation and individualisation.

*Motto: Teacher has to prepare a learner so he/she is capable to correct oneself, otherwise a result of learning is a skilfulness, which depends from teacher's presence*

**Background, framework and purpose:** Author's contribution brings a didactic material as a product of an operational step of the European Social Fund Project: Development of Natural Sciences Competences.

An aim's group is presented by the learners of secondary vocational educational programme, namely nutritionists - confectioners.

Proceeding from the catalogue of knowledge for subjects Natural Science and Elementary knowledge of Biotechnology and Nutrition the concept soda is selected as chemical compound and simultaneously as an agent for rising too.

The authors defined the curricular planned goals' activities from the aspect of generic competences, especially "the ability of learning and problem solving", as well as other topical science competences. The stimulation of natural science competences for the vocational needs is a key goal of presented research. For this purpose the didactic material is articulated to mainly focus on the principles of differentiation with regard to the activities and individualisation from the point of view of learners' interest abilities.

**Methods:** The learners-confectioners acquire above mentioned competences by using role play, namely historians, experimenters and consumers. The material is methodologically articulated by using hands on experimenting and heterogeneous group working. From the necessity of successful teaching and learning this didactic material is composed from guidelines for teachers, learning guide and learning-experimental papers for learners.

**Results:** An empirical evaluation of competence realisation has been done using an optional evaluating instrumentation, which could point at three generic competences of future confectioners acquired by the performance of planned activities, as following: ability of learning and problem solving, ability of information collection and ability of autonomous and individual teamwork.

**Conclusion and implication:** The findings and conclusions as a result of empiric evaluation of learning processing of various method's activities by using the optional didactic material are the subject of further discussion. The covered learning content is a part of fundamental educational standard of chemistry and an opportunity for performing the activities simultaneously, giving the learners the opportunity to acquire competences necessary to perform tasks and needs of both vocational work skills as well as the daily operations.

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## **Popularization of chemistry as a base of efficient education**

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The international research studies on science and chemistry education have shown the low interest of students both elementary and grammar school. Teacher plays a significant role as to familiarize students with subject so that they can understand it and become friendly with it. Teacher should be able to popularize chemistry as a school subject. Within the pre-graduate training of the chemistry teachers students are guided to acquire basic principles of planning, demonstration and evaluation of the chemical experiments. In addition, they learn to integrate experiment with a facultative education form in such a way to make the public acquainted with chemistry. Chemistry on the Silesian-Ostravian Castle and Santa Claus Party represent the most significant events for general public. The students are to prepare both events and their contents in order to motivate the elementary and grammar school students as well as other visitors of the events (children, parents, and teachers). The events preparations are based on assumption that the students will be able to use the skills acquired by the events realization in their pedagogical practice.



## **Attitudes of the trainers for the use of modern practices in teaching medical students**

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Keywords: attitude to learning, professional competences, medical students, medical education

Contemporary learning process is very complex due to simultaneous operation of several, at times even opposing factors: e.g., the vast amount of information and lack of criteria necessary and sufficient basic knowledge; availability of modern advanced techniques for diagnosis and research and the inability to use it directly in the learning process; unappreciation of the subjective factor and the individual approach to training in preparation of specialists who will work in future.

These and other reasons put the contemporary trainer in a situation to wield a large amount of knowledge and possessing the art of conceptualization exposes them to visualize an appropriate dose of theoretical constructs so that they are able to effectively apply them in practice; have the ability to work with an audience groups students or even individual ones, and finally possess the art to motivate students to study and practical realization of the goals. Our research on attitudes and experiences of the trainers to use modern practices in education shows the strengths and weaknesses of this process and mastery of didactic art to apply the above components in the learning processes.



# Identification of Benzoic Acid in Food as School Experiment

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Food ingredients pertain to the substances, which are added to different product. They improve, for example, flavour, odour and colour of food. Well known additives put to preservatives. This substances classify to antimicrobial compounds and antioxidants.

Antimicrobial compounds protect a food from undesirable microorganisms. Inorganic and organic acids or salts can act as the preservatives. Benzoic acid and sodium benzoate are possible to use as the antimycotic agent. The amount 500-1000 mg.kg-1 of the benzoic acid can inhibit the growth of the yeast and mould. Benzoic acid can be the natural component of a some fruits.

Benzoic acid is a widely used preservative in the food industry. For this reason are suitable to propose a school chemical experiment from this area. Method of the benzoic acid identification in food products (mustard, ketchup) on TLC principles was elaborated. The most product contain sodium benzoate, Sample of product is necessary to acidify (conversion of sodium benzoate to benzoic acid). Benzoic acid was extracted by toluene. The extract was developed by the mixture of toluene and ethyl-acetate (70:30) on Silica Gel with luminiscent indicator. Chromatogram was detected of UV lamp ( $\lambda = 254 \text{ nm}$ ). The results of analysis the different mustards and ketchups confirmed the presence of benzoic acid in the products.

The simple experiment enriches the collection of school chemical experiments on theme Chemistry and Society. That experiments are very interesting and motivate for grammar school students and university students of chemistry education.

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# A Needs Analysis Survey: The Case of Business Letter Writing in Latvia

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Keywords: ESP, needs analysis, business writing.

**Background, framework and purpose:** The aim of ESP courses is to equip the learners with a certain English proficiency level for a situation where the language is going to be used, i.e., target needs. In the last few years, needs analysis researches have tended to an increased interest in investigating the most effective ways of improving the ability of workers in using ESP in the workplace. One of the skills required in the field of business is writing. Accordingly, the current study aims to determine the letter writing needs of business students.

**Methods:** A complete list of sample business letters was taken to experts in the field of business. The long list was truncated to be more easily handled in the second phase of the study. The newly drawn list of letters was sent to five firms in Latvia to find the most frequent topics they deal with in their daily correspondence as their needs.

**Results:** For the present study the business students' letter writing needs are defined as the most frequent letter subject marked by experts in the firms. Those letters the frequencies of which were higher than 10 i.e. marked by more than 40% of experts were selected as their writing needs.

**Conclusions and implications:** The findings of the current research can have two major implementations for teaching English for business. Firstly, this can provide English for business (EFT) teachers with a list of letter writing genres they are mostly in need of.

Secondly, the present findings can serve a useful reference for syllabus design in general and designing an appropriate writing syllabus in particular



# Teachers Examining Aspects of Everyday Scientific Practice Inside Laboratories: Implications for the design of school-based learning environments in science

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Keywords: K-12 learning/teaching environments in science, science teachers' professional development, NOS

This study examines the links between a) pre- and in-service K-12 teachers' knowledge of science and scientific practices and b) their experiences with the everyday work of science and scientists taking place inside scientific laboratories. Through this study, we seek to understand how such experiences inside laboratories affect the learning environments these teachers design or plan to design; specifically, we focus on school-based designs that can better reflect or translate the way science is practiced in the world. Our theoretical perspectives emerge out of work done in the sociology and anthropology of science (Kuhn, 1962; Latour, 1987; Latour, 1999; Latour, and Woolgar, 1986), as well as from studies that have attempted to apply those perspectives within the educational contexts (Brown, Collins, & Duguid, 1989; Resnick, 1987; Hall & Stevens, 1995; Hall, R., & Torralba, J. A. 1997; Torralba, 2007). We use these theoretical orientations to help us construct a framework; this framework helps generate guiding questions to examine the design of school-based learning environments in science and the role of teachers in constructing those environments. Using teachers' reports emerging from their own experiences inside laboratories and our own analytical records of scientists (Torralba, 2007) and students, we employ a mode of inquiry that relies on comparing and contrasting elements of laboratories and classrooms as a way to examine the existing and the possible in relation to teaching and learning. We make use of multiple records, including pre and post evaluations of teachers' opinions and knowledge about science, ethnographic and cognitive records of scientists and students in relation to learning and teaching, and records produced by teachers while visiting scientific laboratories. We also utilize emergent designs of learning environments these teachers produced as part of a formal graduate course in the Nature of Science. We find that after their experiences inside labs, pre- and in-service teachers' perspectives on science and scientific practice shifted in relationship with their own professional trajectory. We discuss the educational implications of our findings, with emphasis on the design these teachers are likely to engage in and the effect such designs may have on their students' access to authentic images of science.

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# New technologies in Laboratory Secondary Education: the use of pressure sensors and Microcomputer Based Laboratory equipment

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Keywords: Microcomputer Based Laboratory MBL, Secondary chemistry, Pressure Sensor, Probeware, Inquiry task

**Background, framework and purpose:** The use of Microcomputer Based Laboratory (MBL) technology where sensors, connected to a computer through an interphase, can measure physical variables has been strongly recommended by many science educators who adopt a constructivist approach to education. (Bernhard, J. 2003; Pintó, et al. 2004 ; Sassi et al, 2005; Tortosa, 2008). The advantages of using inquiry based tasks in secondary school chemistry with the use of sensors have been demonstrated, (Tortosa, Pintó & Saez 2008). Pressure variations are difficult to measure with classical school equipment, but easy to measure with a pressure sensor.

Our purpose is to present research-based laboratory tasks, related to pressure in the Secondary School Chemistry Curricula in Catalonia (Spain).

**Methodology:** When designing the tasks the following features have been taken into account: The use of common secondary school equipment; short experimentation time, relation with Chemistry curricula concepts and inquiry based and contextualized work.

**Results:** To measure pressure and its variations, the device described in Tortosa (2008) has been used. Contextualized inquiry-based tasks for students have been prepared involving the concepts of vapor pressure, rate of reaction and vaporization.

**Conclusions and implications:** The measure of pressure, difficult to make with classical equipment, is easy with sensors and MBL equipment; this fact broadens the range of experiments to be performed in secondary schools. The utilization of inquiry tasks to work with the concept of pressure, will give students the opportunity to practice skills related to this variable, and consequently to improve their science competency.

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# Simulation of domestic heating plants

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Measurements of natural gas consumptions during 8 years will be presented and used to simulate domestic heating plants with gas boilers. The apartment measures 100 m<sup>2</sup> (AREA) and is heated by a high efficiency boiler (22 kW).

The students who lived in the apartment changed over the years. Their presence during the week was not constant (5 or 7 days) and their choice of the room temperature (18-22 °C) by the heating system control was different too. The total annual consumption beginning from September, are compared.

The exit flue gas temperature of a conventional gas fired boiler is usually high and a great amount of heat energy is lost to the environment. In this paper, based on experimental data of traditional and condensing boilers, the recoverable heat and the efficiency improvement potential of different heat recovery schemes at various exit flue gas temperatures will be presented.

The payback period method has been used to analyze the feasibility of retrofitting a conventional gas fired boiler into a condensing boiler in a heating system in detail. The results show that the most economical exit flue gas temperature is 40–55 °C when a conventional natural gas fired boiler is retrofitted into a condensing boiler simply by adding a condensing heat exchanger.

In such a boiler, the exit flue gas is reduced to such a low temperature that the water vapor can be condensed, and the latent heat released can be recovered. As such, the thermal efficiency of the boiler can be significantly increased. If the low heating value is still taken as the calculation basis, the efficiency can be as high as, or higher than 100%. Previous research has shown that SO<sub>x</sub>, NO<sub>x</sub>, dust and soot, etc., which are the constituents of the flue gas, can be partially, even totally, dissolved in the condensed water, and the pollutants emitted to the environment can be noticeably reduced. Therefore, it is of great significance both to energy saving and environmental protection to utilize condensing boilers.

Sinusoidal loads from zero to maximum load (less than 100%) during a season seem to be acceptable in apartment heating plants. The relationship between energy consumption and energy demand in cyclical operation can be used with a sufficient degree of precision to calculate the seasonal consumption as a function of the sinusoidal load during the season.

This relationship can be used for condensing boilers and for other kinds of boilers, and for the usual regulation systems as soon as the appropriate values of the constants have been experimentally defined. The evaluation of the seasonal efficiency of a boiler requires the knowledge of the efficiency at some loads.

By comparing the seasonal efficiencies it can be assumed that:

- The seasonal efficiency of a condensing boiler can be higher by 25% than the efficiency of traditional boilers.
- SO<sub>x</sub>, NO<sub>x</sub>, dust and soot, etc., which are the constituents of the flue gas, can be dissolved in the condensed water, and the pollutants emitted to the environment can be noticeably reduced.
- It is of great significance both to environmental protection and energy saving to utilize condensing boilers.

# Identification of the misunderstandings of pupils revealed by their choice of answers to a test of understanding of concepts of motion

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Keywords: test of understanding, distractor analysis, item response theory, Rasch model, misunderstanding

Kinematics is the study of motion without being concerned about its causes. Kinematics is a domain which causes much difficulty to the pupils, mainly because they interpret the phenomena of motion with the aid of cognitive schemas which grew from their interactions with phenomena of their daily life (Halloun, 2003). These schemas can interfere with the learning of scientific concepts and are not habitually discerned by the traditional tests. In order to systematize the collection of data and their analysis to establish a quick and efficient diagnosis, objective tests were conceived using research on the cognitive schemas of the pupils in kinematics (Sadler, 1998). Procedure consists above all in identifying the main cognitive schemas which the pupils have concerning a kinematics concept, then to conceive items with numerous choices where correct answer is chosen among group of distractors, constituted by the main schemas spotted at the pupils (Treagust, 1995). Yet these distractors are all the more efficient as they are credible for the pupils and their use would increase the discrimination as well as the fidelity of a test (Haladyna, 2002). Nevertheless, rather than to allocate them a role centered only on the improvement of psychometrics qualities of a test, some researchers advanced that the use of the information contained in the choice of distractors would give information about the progress of the pupils in their understanding (Andrich, Lyne, Sheridan & Luo, 2001). Thus, the objective of this research is to identify to which degree of understanding the choice of a particular distractor becomes attractive for the pupil and to which degree of understanding the choice of a distractor is abandoned in favor of the good answer. Such knowledge would allow us to determine for a pupil whose understanding is partial not only what he understands and does not understand of a given concept but also to locate his understanding in relation to the mastery of this concept (Wilson, 2005). A test of understanding of concepts of kinematics was distributed to 165 pupils of a physics course in a secondary school in Canada. This test included 30 questions with multiple choice of answers (Trudel, Parent and Auger, 2008). An analysis of answers given by the pupils was accomplished with the aid of the Rasch extended logistic using the software Rumm 2020 (Andrich & al. 2001). The analysis shows that, concerning the majority of the questions of the test of understanding of concepts kinematics, only some distractors were chosen by the pupils and thus were efficient. For each of these distractors, we determine, on the scale of understanding defined by test, an interval where these distractors were likely to be chosen by the pupils. We conclude by offering suggestions to science teachers for using the information drawn from distractors choice by pupils in a formative way, for example in choosing pedagogical correctives to their pupils' incomprehensions. Moreover, limits of this research and perspectives about future research are offered on the use of distractors in multiple choice questions.

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# Science teachers' insights toward using marbling art activity for teaching of chemical concepts in science and technology course

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Keywords: Marbling Art, Science Teacher, Chemistry Learning

Art and science as a concept are commented separately by self-meanings, but they express human activities (Garoian and Mathews, 1996). Chemistry is an important science area for visual art. Both art and chemistry can be strong tools of social control and social change. Art and chemistry support each other whenever one of them seems weak. Consequently, getting a close relationship between art and chemistry presents an effective learning approach in order to understand chemical concepts (Greenberg, 1988). A new generation who are integrating chemistry with art always protect social beliefs, values and cultures. In this way, they can learn chemical concepts more easily and improve their scientific skills through art activity in the course. They also keep their cultural heritage alive. In this process, teachers play important role to spread cultural, technological and scientific assets by integrating science and art. For this purpose, the workshop toward Science Teachers was organized in Izmir, Turkey, May 2008. The workshop was applied during two days period including total 16 hours. This study aims to investigate the applicability of MAC for teaching of chemical concepts in Science and Technology Course (STC). Therefore, the workshop focused on demonstrating some chemical concepts such as the solubility, the density, the surface tension, the distribution of matter into liquid, the surface absorption. This is a qualitative research study. Participants of this MAC workshop were Science Teachers (n=22). By using random sampling, five teachers were chosen for the interview. The semi-structured interview protocol consisting 10 main items was used to get teachers' insights about using (MAC) for teaching of chemical concepts in STC. Data of the study were gathered by the semi-structured interview protocol and observations. Data were analyzed in terms of content analysis.

The insights of Science Teachers toward using (MAC) in STC were determined by the rate of positive and negative meaningful phrases in interview documents. The rate of these positive meaningful phrases is computed as 83 %. In this context, using (MAC) in STC is a useful, interesting and suitable activity toward constructivist learning and multiple intelligence approaches. As the rate of these negative meaningful phrases, MAC can be applied in safe and optimum constructivist learning environments having limited students. Teachers suggested that integration of art and science with visual arts such as (MAC) should be supported by educating Science Teachers through seminar or conferences, be adapted to course books, text and curriculum in STC. Furthermore, they emphasized that lacking of integration art and science in Turkey is related with having economic problems and developing of technology, socio-cultural values and religious beliefs.

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# Didactic presentation as an instrument of enhancing science teaching clarity

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Keywords: PowerPoint presentation, general chemistry, teaching clarity

Science deals with phenomena that can be easy to observe in the real world and study objects which can be manipulated. On the other hand, it describes objects and phenomena that are not accessible to our observation. A curriculum which deals with such objects and phenomena is very abstract, theoretical and often very difficult for pupils to follow. In the chemistry this primarily concerns the general chemistry curriculum: the structure of atoms and molecules, the structure of substances, the principle of chemical reactions, etc. This part of chemistry is hard for students to understand thanks to its difficulty. This leads to its low popularity which is reflected in the attitude towards the whole subject of chemistry. Therefore, we are looking for ways to increase the curriculum clarity.

We decided to exploit the possibilities of visual representation of objects and phenomena using graphics software (MS Paint) and programs that aim to create chemical formulas, structures and apparatuses (ChemSketch). We decided to process some particular units of the curriculum in the form of PowerPoint presentations. To create a presentation that would have the maximum benefit for the teaching and which would eliminate as many potential negative impacts on the educational process as possible, we first conduct an extensive search of literature, especially research articles that relate to the impact of graphics on the process of learning and understanding [1, 2] and visualization science curriculum [3]. We also build on our own experience with the creation and the use of presentations in the classroom. The prepared presentation were subsequently verified during actual teaching at secondary schools [4].

When making presentations, we primarily started with the principle of maximum use of graphic and figurative elements, i.e. pictures, diagrams, photos, animations, graphs and tables. We tried to obey the principles relating to colour and fonts (e.g. font size of at least 20 points, use sans serif font). We also use the observation that while coloured text attracts attention, black text is more understandable, that the words written in small font attract more attention than the words written in large font and the like. In this way, we have created a collection of 20 presentations of general chemistry, which were verified in the classroom. The subsequent questionnaire investigation of teachers and pupils testing showed that such a presentation has a positive contribution to enhancing clarity of teaching.

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# Augmented reality technology implementation in biology lessons: the research of pupils' opinions

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Introduction. Information communication technology development in education is becoming one of the most important discussion objects of pedagogical community all over the world. Thorough analysis of the scientific information sources shows that in the world it is not limited by well known educational technologies. Nowadays innovative education models which let to use virtual reality and mixed surrounding in the learning surrounding are being created (Thorsteinsson, Page, 2008). Augmented reality technology (thereinafter ART) is used to create such surrounding, and it lets the users not only observe the view augmented with virtual information but also directly interact with the real teaching/learning objects.

According M.Adams (2005), this technology could be useful while learning. The goal of the recent research was to reveal comprehensive school pupils' opinion about ART based teaching/learning means usefulness while learning human digestive system in the context of the traditional teaching/learning means.

Methodology of the research. During the research a questionnaire of closed type was used and the most frequently used teaching/learning means and e-teaching means based upon ART were presented for evaluation. 103 seventh-formers took part in the research. Analysing the research data the descriptive research data analysis (absolute and relative frequencies), statistical research data analysis (Kruskal-Wallis Test, Mann-Whitney Test) and comparative analysis were used.

Results of the research. The analysis of absolute and relative frequencies showed that opinions about usefulness of teaching/learning means while learning human digestive system are not the same. Comparing the data of three independent grips statistically significant differences were committed in five positions: there were differently evaluated animation on the Internet while learning the organs of digestive system, alimentary stuff segmentation and absorption, material visual means- while learning alimentary stuff segmentation and absorption. Comparison of 2 independent grips (in different pairs) let specify which groups differently evaluated usefulness of teaching/learning means. It, in turn, made it possible to determine influence of the experimental e-teaching/learning means upon evaluation of traditional means usefulness.

## Conclusions:

- E-teaching/learning means based upon ART (thereinafter: ARTM) is evaluated as quite useful means while learning human digestive system.
- The use of ARTM influences a part of traditional teaching/learning means evaluation in the aspect of usefulness. The respondents who used ARTM tend to evaluate animation on the Internet as of little value differently from the groups which did not use ARTM. The same group evaluates object visual means much more approvingly.
- Dynamism of visual information influences evaluation of the means. Dynamic audiovisual teaching/learning means (animated film, ARTM) are evaluated as useful. Static visual teaching/learning means, even these based upon information communication technologies (texts and pictures on the Internet), are evaluated as less useful.



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## **Environmental audit as a method of education for sustainable development**

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Environmental audit described as a preliminary environmental review is the activity of all persons affiliated with an institution with the aim to identify and assess the impact of the operation of the institution on the elements of the environment in terms of human work and rest. The audit also indicates the courses of action that should be taken by the community of the institutions audited in order to minimize environmental impacts

Participatory methods of education are recommended in implementation of education for sustainable development. A characteristic feature of these methods is that solutions, which are initially an open question, arise during the educational process. Participatory methods facilitate a direct connection between the learning content and everyday experiences of the learner. An example of this method is the environmental audit of schools or other educational establishments.

The article presents a description of an environmental audit - an object of an educational project – taking into consideration the various stages of implementation and results expected in the field of education, economy and environment.

# Research on Comprehension of the Conservation of Energy Law conducted among Students of Physics and Physics Teachers

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Keywords: physics, teaching, diagnosis, skills, energy

The law of conservation of energy is the fundamental law of science. In the last year some investigations concerning the understanding and applying skills of this law were conducted among physics students who are preparing to teach physics and among physics teachers. Proper understanding of concepts of Kinetic Energy, Gravitational Potential Energy, Elastic Potential Energy, Conservative and Nonconservative Forces and the law of conservation of energy is very important to good understanding of all Science so it is absolutely essential for physics teachers to have sufficient skills in this area.

Our test comprised 15 tasks. All the tasks were of a qualitative nature and no calculations were required. Most of our tasks were patterned by tasks used by Chandrekha Singh and David Rosengrant in their large study performed in the United States some years ago [1]. These tasks were examined by a lot of experts so the probability that they are correct, relevant and cover the topic we are interested in is very high. Yet, while Singh and Rosengrant used multiple-choice questions, we prepared only open tasks, therefore in our study the students and the teachers had to formulate their own answers. To check whether students can differ situations where the law of conservation of mechanical energy is true from situations where some mechanical energy disappears we considered frictional forces in some tasks but air resistance forces were ignored. In some tasks we also considered other nonconservative forces which can also make that mechanical energy will be greater at the end than at the beginning.

Our studies show that students have a lot of difficulties with these problems. The Law of conservation of energy and other concepts were known to the participants of the research. Moreover, they fulfilled properly some tasks which were similar to those from handbooks. Nonetheless, they had great difficulties with examples concerning simple everyday life situations. In fact, we noticed very interesting misconceptions. Only about 10% of the students did not have difficulties with these problems. In some tasks the students could not choose the proper system of bodies for which the conservation of mechanical energy principle can be used. Also, in some cases, the concept of mechanical energy as a sum of potential and kinetic energy was not well understood by the students. Sometimes the respondents treated energy as vector, sometimes they had difficulties in deciding whether to choose the principle of energy conservation or momentum conservation to solve the problem.

The principle of energy conservation is very important to understand our World. To put it differently, it is crucial to comprehend it fully by all those who teach or will teach any course of science or physics. Thus, we do have to stress these topics in our education.

In our article and presentation we will present some tasks from our studies, the detailed results, as well as some interesting misconceptions and conclusions about teaching these topics at schools and universities.

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## **First year chemistry student's skills of solving chemicals problems for the solutions properties.**

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The 62 chemistry students (license study - first course) from the University of Podlasie knowledge and skills of solving chemical problems for the following subjects: pH calculations for the weak and strong acids and bases solutions, hydrolysis, solubility equilibrium in the saturated solutions, calculations of the ions activity and ionic strength, pH of the buffer solutions were investigated. The detailed examination of the student's works (colloquium) during the course of General Chemistry showed that their skills are only sufficient. The students had especially difficulties with the calculations of pH values for the weak acid and bases solutions and buffer solutions.

## **General Chemistry Course in the opinion of Student's.**

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The General Chemistry is the first chemistry course for the license chemistry studies at the University of Podlasie. During the course the students passed 45 hours of lectures, 30 hours of seminars, 30 hours of chemical calculations exercises and 45 hours of laboratory. After the course, the questioner's investigations were performed among the 156 chemistry students from 2007/8, 2008/9 and 2009/10 academic years courses. The students were asked about their activities and troubles during the seminars and chemical calculations exercises. They were also asked about the difficulties of understanding some chemical problems and troubles with proper preparing to the final exam after the course. The results of the investigations will be presented.



## Problems of integration of sciences and humanities in environmental protection study programme

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The contemporary curriculum of Environmental Protection studies combines different branches of knowledge, traditionally defined as sciences and humanities. A lot of content is presented in an interdisciplinary approach. The knowledge and skills from the particular subjects should form a coherent whole. Creation of a teaching subject, universal with regard to programme and methodology, which would pursue the aims of biology teaching, requires the integration of sciences and humanities. The paper presents the results of a survey on the perception of issues of integration of humanities and sciences by students of the Faculty of Mathematics and Sciences of the Jan Długosz Academy of Education in Częstochowa. The survey was administered to 120 first, second and fifth-year students. Questions of the survey addressed two issues investigated at the same time: evaluation of the impact of the development of chemistry on the history of sciences and problems of integration of sciences and humanities in the Environmental Protection study programme. The paper discusses some selected issues which constitute a part of the analysis of the answers to the survey given by students beginning their studies (first and second year) and finishing their studies (fifth year). It can be assumed that perception of the integration of sciences and humanities in the Environmental Protection study programme may indirectly affect the analysis of the students' self-evaluation of their professional qualifications.

## How can drawing concept maps improve students' understanding of intermolecular forces

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Keywords: science competences, scientific literacy, concept maps, intermolecular forces, cross-curricular integration

**Background, framework and purpose:** As a part of national project "Development of Science Competences" carried out by the Faculty of Natural Sciences and Mathematics from the University of Maribor in Slovenia, teaching strategies, methods and techniques have been designed to develop science competences in order to raise scientific literacy among students. Chemistry as a scientific discipline is in most cases considered as abstract, its topics are often very difficult to learn as well as to be understood. Depending on the complexity of certain chemistry content, we note that students often have difficulty finding the right approach for learning. There is also a lack of cross-curricular integration in class. Students therefore cannot directly connect their knowledge and information from various fields. To achieve both, we designed teaching materials

based on creating concept maps while reading a thematic chemical text in the English language, which is the first foreign language for Slovenian students. After obtaining new information the main objective of this activity is to create hierarchical network of concepts based on the nature of their interrelationships.

**Methods:** Using the combination of text based method and the method of structuring data into systems, we first performed a test of the teaching materials on 30 Slovenian students who attend grammar school. They were given an English text on chemical topic "Intermolecular forces". Their task was to read the text, underline and write down the most important keywords, translate them into Slovene and make hierarchical arrangements among themselves. What followed was drawing concept maps based on selected keywords and by using specific computer software. Prior to work, the chemistry teacher explained the theoretical basics about the meaning and forms of concept maps as well as introduced the students with different computer programmes for drawing. The teaching material for the next lesson encourages students to represent their own working strategy and argumentatively explain the reasons for the selection of certain forms of concept maps, the order of tracking of selected concepts and the linkages between key concepts.

**Results:** According to the fact that the testing was done on 30 students, we can only speak of preliminary results, which serve more as guidelines for the improvement of produced teaching materials. But it is clear from this finding that this approach enabled the students to develop their reading skills in a foreign language, to promote logical thinking and to learn how to systematically structure the data. Even if the chosen text contained slightly more difficult technical terms in English, the students were motivated by this kind of work.

**Conclusion and implication:** Following this approach the learning content could be more systematically processed, which caused better understanding. We also assured cross-curricular integration, connecting chemistry with English language and Computer Science. Certainly it will be necessary to carry out additional testing on the larger population of students, which is scheduled for this autumn. This will provide more tangible results on the effectiveness of introducing new strategies of work into chemistry teaching.

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# Neogeographic approach in scientific education

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Keywords: GPS, neogeography, chemical analysis, geochemistry, electrical conductivity

Neogeography is a usage of geographical tools for utilization by a non-expert group of users. It has been rapidly developing last ten years and is founded on (a) availability of Global Positioning System (GPS) receivers, that allows to obtain very precise geographical position (b) GoogleEarth service, that allows linking geographical position with satellite images and (c) programs as GPS Track Maker or OziExplorer, that allows linking geographical position with other raster images (for example, maps).

However, the possibilities of neogeographic approach are much wider. It is the best basis to combine geography, chemistry, biology and physics. It gets a prospect of really holistic scientific education. The first step is very simple: to determine one or several chemical, physical or biological parameters in points with certain position. The obtained data can be presented in very different ways: (a) a parameter versus the distance from a particular point or line (for example, a source of a substance) (b) two-dimension distribution of parameter; (c) put the results onto a map or space image. The results help to trace the influence of different objects on the environment and reveal geochemical, geophysical and ecological patterns.

The most interesting is the combination of parameters of different subject that helps to penetrate into concealed bonds in the environment. For example, superposing a map of soil pH and a map of predominant plant species one can see the preferable acidity of soil to a plant, connecting thus chemistry and biology. Superposing a map of air humidity and number of mosquitoes one can learn a lot about behavior of mosquitoes, connecting physics and biology. At Fig.1 electrical conductivity of two join streams is shown. One can see, that the zone of mixing (where the electrical conductivity is different near different banks) lasts for 50 meters, despite the streams are less than 2 meters wide. The other conclusion (that is physical, not chemical) – that the main stream carries four times more of water, than the tributary. It is an example of joining chemistry and physics using neogeographic approach.

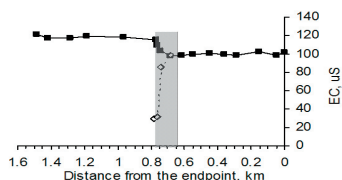


Fig 1. The electrical conductivity of a stream (black squares) and its tributary (white rhombs). The zone of mixing is marked grey.

To facilitate sharing the information, an open database with simple interface was elaborated (<http://maps.s192.ru/>, V. Ilyin), that is described in another abstract.

Thus, availability of GPS receivers and systems for easy measuring of different environmental parameters enriches the scientific education with a new powerful tool, providing holistic approach, where landscape is a scene, where a complicated play called life is going on.

## Open geochemical database

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Keywords: database, geochemistry, hydrochemistry

We regard “geochemical data” as data on chemical parameters of the environment, linked with the geographical position of the corresponding point. Boosting development of global positioning system (GPS) and measuring instruments allows fast collecting of huge amounts of geochemical data by non-expert users (including pupils and students). However, the non-expert users cannot share their data. It reduces all the advantages of collection data by large groups of non-experts. To make all the data available and easy to find, it seems reasonable to elaborate an open database of geochemical information, accessible via Internet. It also seems reasonable to link the data with maps or space images, for example, from GoogleEarth service.

For this purpose an open geochemical database is being elaborating (<http://maps.sch192.ru>). Any user after registration can upload geochemical data (position, type of parameter and value of the parameter) and edit them. Every user (including unregistered) can (a) extract the values of parameters, fulfilling desired conditions and (b) see the points, linked to GoogleEarth space image, colored according to a value of selected parameter. Then he can treat extracted values any way he likes.

There are the following data types in the database: authors, points, seasons and parameters. Author is a person, who publishes the data. Every author can declare his own profile. A point is characterized by its geographical position and type of the object (i.e. river, lake etc). Value of parameters are linked to a point, an author and a season, when they were obtained. A user can choose a parameter to place on GoogleEarth space image and a scale to color the points on the image according to the value of a parameter.

Currently (December, 2009) the database is under construction, but several functions (uploading data on pH and electrical conductivity and placing colored points onto GoogleEarth space image) are available yet. We hope that open database will help exchanging geochemical information and call everybody for sharing the geochemical data. We also call for feedback on the structure, interface and operation of the database.



# Various styles of presenting chemical content and their influence on memorizing and understanding of selected issues

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Keywords: various style of presenting chemical content, inorganic chemistry, memorizing and understanding, lower secondary school

Nowadays students have an opportunity to use numerous information sources. Undoubtedly, the factual correctness of these sources is of fundamental significance in the learning process. What is also essential, considering a methodological aspect, is how the information is presented through particular styles. The aim of the research was to establish the influence of the chemical material presentation style on the learning process.

The research was conducted among almost three hundred students attending lower secondary schools in Zakopane. The learning material containing basic information about sulfur as a chemical element was presented in three different styles:

1. an encyclopedic note
2. a rhyming poem
3. a condensed summary

After acquainting themselves with this information, students were asked to provide their answer in a single-choice test. The test contained eleven questions checking students' understanding and memorizing ability. The students could also create their own notes including: main points, key words, drawings, and other elements facilitating assimilation of information.

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## Supporting an implementation of inquiry based science education via involvement of scientific community

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Key words: inquiry based science education, primary education, cognitive skills, involvement of scientific community

Inquiry based science education (IBSE) represents a specific educational conception which tries to implement a real scientific experiment into conditions of primary science education. The main reason is to support development of cognitive skills. The implementation of IBSE is connected with different kinds of practical problems. As the conception requires the pupils to make a serious cognitive effort, the motivational process starts to become more important; what more, the kind of used motivation becomes more important as well. One of the possible ways how to deal the problem with motivation (and some other problems connected with the IBSE implementation) is to create really vivid and effective involvement of scientific communities (like members of scientific academies, researchers from universities or students of scientific studies). The article analyzes positive and negative aspects and experience of the involvement and tries to suggest the best way how to create enough usable and flexible system of involvement. The suggestions result from experience with IBSE implementation under POLLEN project ([www.pollen-europa.net](http://www.pollen-europa.net)).



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