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CHEMISTRY IS ALL AROUND NETWORK

518300-LLP-2011-IT-COMENIUS-CNW

Successful Experiences in Chemistry Teaching in Europe

Lifelong Learning Programme

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Successful Experiences in Chemistry Teaching in Europe

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Context

The identified background of the project idea relies on the evidence of common needs within the countries involved and in Europe in general, related to the insufficient diffusion of scientific culture and awareness, that starting from the school level (primary and secondary education) affects all levels of educational and training systems and therefore citizens in general.

Promoting Life Long Learning strategies for scientific issues is much more difficult, if compared to other subject areas (e.g. humanistic subjects, business management, language learning) as when the compulsory educational pathways end up, those that are not specifically interested in science are much more likely to abandon completely the subject.

Moreover teachers, the key actors of the promotion of scientific awareness, have to face a major challenge coming from the fact that the speed of the development of scientific knowledge is constantly increasing.

The scientific background of a teacher who started teaching 10 years ago, without a constant update, risks to become soon completely obsolete. But often the language used by most advanced researches is too complicated even for teachers and the knowledge gap between university and research centres and the teachers themselves tends to become too big to be handled, with the most negative effects falling on the students who exit school unprepared to develop their knowledge in scientific issues.

This phenomenon risks to create concrete and consistent obstacles to the achievement of some of the main objectives of the Europe 2020 strategy aims related to the competitiveness and the excellence of scientific research in Europe and its capacity to answer and anticipate the needs of the market and the promotion of science education and knowledge among European citizens.

The Chemistry Is All Around Network project aims at stimulating the interest of students towards the study of chemistry. It is based on the collaboration of school teachers, scientific experts and university researchers and each year foresees different activities within a specific area of interest: 1. students' motivation; 2. teachers' training; 3. successful experiences and good practices.

The first year of work, dedicated to analyse students' motivation to study chemistry in the countries involved and to discuss about concrete solutions, was completed in December 2012.

The second year of work, completed in December 2013, was dedicated to analyse the training of teachers in the different countries, with a special focus on science/chemistry teachers.

The third year, still in progress, is dedicated to identify successful experiences and good practices that can be helpful to improve the teaching of chemistry/science, since the early years of school.

The material produced during the three years (papers, reports, teaching resources etc.) is available on the project portal.

The main results related to the "Successful Experiences" research area will be presented in the following paragraphs.

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1. National sources of successful experiences

This paragraph is dedicated to provide few examples of national sources where teachers can find successful experiences in science/chemistry teaching to get inspiration for their work in classroom. The cited sources are of different types, but mainly sites, magazines and specific conferences.

1.1 Belgium

The official website of education in French-speaking Belgium is *enseignement.be* [1]. It contains among many things a list of resources and publications on education available for all, as well as news on many education-related events, initiatives and projects, videos, curricula, legal texts, lists of skills, a forum...

Another related source of information is the magazine *Prof* [2]. This monthly magazine, published by the Ministry of Education, is sent in paper format to all teachers, and can be downloaded for free on *enseignement.be*. It contains articles by experts on all facets of education, from legislations to specific initiatives.

Regarding ICT resources, the website of the project *École Numérique* contains several links to websites approved by the Ministry of education with digital educational resources [3]. Still on *École Numérique*, several teachers provide testimonials [8] about their use of educational resources.

1.2 Bulgaria

The most significant forum for exchange of professional experience and good teaching practices in chemistry education is the *National Conference of Chemistry Teachers*, which takes place every two years thanks to the joint efforts of MES (the Ministry of Education and Science), Sofia university “St. Kliment Ohridski“ and the Union of Chemists in Bulgaria. Apart from chemistry teachers from across the country, it involves university professors and experts from institutions in charge with the national policy on science and chemistry education.

Az Buki National Publishing House for Education and Science of MES [4] publishes the only national weekly newspaper on education and science Az Buki and nine science journals, each of them presents successful educational practice including in chemistry education among large number of students, teachers and experts.

Bulgarian Journal of Science Education [5] provides a room for sharing and discussing ideas, news and results about new ways of teaching as well as of presenting new experimental and theoretical aspects of chemical science. “Among the goals of the journal is to bridge the gaps between the educational research and the school practice. All educational levels - from the early science education, secondary education, vocational education to the tertiary education and the lifelong education, are on the focus.

There are also web-based forms offering platform for sharing successful teaching experience. The most important of them are:

• *National education portal*, developed by the MES as a step to implement the e-learning as educational practice in Bulgarian schools [6];

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• *Teacher.bg* or *National network of innovative teachers*, supported by MICROSOFT Bulgaria - the portal aims to improve the teachers' qualification and skill in implementation of ICTs in educational process and also to share the best examples of teaching practice in their application at school [7].

1.3 Czech Republic

SCIENTIX [8] is a successful National conference designed primarily for teachers of primary and secondary schools who teach maths, science and technology, and also for professionals who are involved in innovation of the areas of mathematics, science and technical subjects. There were practical workshops, where the participants tested a variety of innovative teaching methods in practice. The main goal of this conference was that each teacher took particular inspiration for his teaching. The conference was organized by Association of European Schoolnet (EUN) in collaboration with the Centre for International Cooperation.

The *Institute for Support of Innovative Education* is focused on supporting innovative methods and trends, mediates information, initiatives for teachers, experts and schools. The institute is focused on Montessori School, Waldorf School, intercultural schools, intuitive education etc. It provides an online portal [9] with a list of successful schools which involved innovative teaching in their daily practice.

1.4 Greece

The *Panhellenic Conference on Science Education and ICT in Education* is a conference series organized every 2 years and it is attended by science educators of all levels (primary – secondary – tertiary education) from all over the country. Conference proceedings are available freely on the site of the recently founded (2011) "Association for Science Education and Technology" (ΕΝΕΦΕΤ – ENEPHET) [10]. The amount of papers presented in every conference of this series is over 100 and at least 30% of them are related with chemistry education. The majority of these papers are related with the design, application as well as assessment of novel approaches for teaching chemistry in secondary school (as well as chemistry related subjects in primary school).

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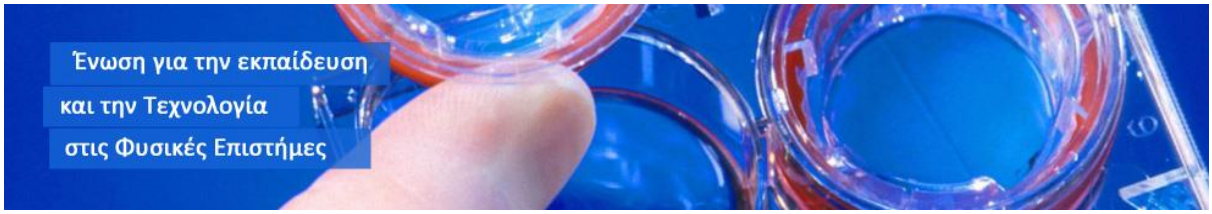

A second useful source is the conference *proceedings of the conference series organized by the Greek Scientific Association of ICT in Education* (ΕΤΠΕ – ETPE) [11]. Topics of the presented papers cover a very wide range of disciplines with science (and chemistry) being one of them. As implied from the conference title, the teaching approaches presented in this conference actively exploit some form of ICT. In parallel with the "ICT in Education", another conference series named *Panhellenic Conference on Integration and Use of ICT in the Educational Process* is organized by ETPE every 2 years starting from 2009; papers are available freely in the official site of ETPE [11].

Other important sources are the websites of the *Secondary Education Science Laboratory Centers* (EKFEs). The EKFE is an educational structure whose main aim is the active support of all aspects of laboratorial teaching of physical sciences to all in-service science teachers in the school units. As an example of successful experiences in chemistry teaching, you may refer to a series of them, presented at the website of EKFE Ampelokipon [12].

Chemistry teachers often upload teaching resources which they have actually tested in their classes in websites of the individual school units or related educational sites. These resources are accompanied by additional material which can significantly aid successful implementation (worksheets, suggestions, even videos of the actual lessons). Two characteristic examples of such sites are the following: i) the teaching resources uploaded at the site of *5th Upper Secondary School (Lyceum) of Petroupolis* [13] and, ii) the model teaching lessons (accompanied by videos) that were conducted by chemistry teachers serving in *secondary schools of Cyclades Islands* during 2013-14 [14].

A collection of good practices in teaching different chemistry topics can be found in the site of the in-service teacher training program known as *Major training* ("Meizona Epimorfosi") [15]. These good practices were produced by trainees (active chemistry teachers in secondary school) of this optional training program which took place between June – December 2011.

1.5 Ireland

Chemistry in Action! Magazine is published three times annually and sent free of charge to approximately seven hundred Irish chemistry/science teachers. It aims to keep the teachers up to date with new ideas in chemistry and pedagogies, and includes resource news and event updates. The magazine is sponsored by chemical and pharmaceutical industries as part of their education and outreach activities [16]

The ChemEd-Ireland annual conference is an annual one-day conference held to provide an opportunity to share ideas and resources relevant to teaching chemistry and science in Ireland [17]. It is attended by both pre-service and in-service teachers and includes a mixture of interactive talks and workshops. The theme of the 2013 conference, which was hosted by Limerick Institute of Technology, was New Perspectives for Chemistry Teaching and the conference proceedings will be published in Chemistry in Action! in 2014. The attendees had the opportunity to hear from the new Chief Examiner for Chemistry, Dr. Fiona Desmond, and to share new ideas on the use of technologies in the classroom among other topics. This event is supported by the PDST, RSC and the Society for the Chemical Industry.

The *National Centre for Excellence in Maths and Science Teaching & Learning* (NCE-MSTL) [18] was developed to address issues in the teaching and learning in science and mathematics by conducting

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best practice, high level evidence-based research into teaching and learning in mathematics and science - incorporating all learning environments - formal, non-formal and informal. It is collaborating and sharing information with all universities and institutes in order to formulate strategies that enhance mathematics and science teaching and learning from primary school, through secondary school to third level and fourth level. In addition it aims to translate existing research into effective best practice in mathematics and science teaching and learning, and to achieve this through designing, informing, advising and delivering nationally recognised evidence based CPD programmes.

NCE-MSTL
National Centre for Excellence in Mathematics and Science Teaching and Learning

The *Institute of Chemistry of Ireland* is the professional body representing chemists in Ireland. It promotes good practice in chemistry and maintains strong links between chemistry education and industry. The Institute produces a magazine Irish Chemical News and holds an annual congress [19]

1.6 Italy

The site most known by teachers belongs to the publisher *Zanichelli.* The textbooks by Zanichelli are the most common in Italian schools of each grade. The site [20] gives access to useful material such as concept maps, power point lessons, interactive questionnaires for students, videos and more.
The site of the *national project PLS (Scientific Degrees Plan)* is strongly recommended by the Ministry of Education (MIUR). At the project site [21] you can access to several successful experiences, designed and carried out by universities for secondary schools.

PIANO NAZIONALE LAUREE SCIENTIFICHE

Good sources to address scientific issues at school are also some magazines (also available in digital format), such as:
- *Le Scienze*: is a monthly magazine devoted to scientific popularization. It is the Italian edition of Scientific American. In addition to basic science, it pays particular attention to the impact of science and technology to technical progress [22].
- *Linx Magazine* - the magazine of science for class: it is addressed to teachers and dedicated to the teaching of the sciences. It provides insights, updates, practical learning activities, exercises and questionnaires for students [23].
- *Nuova secondaria*: is a magazine dedicated to the cultural and professional training of teachers and school leaders of secondary school. It provides didactic disciplinary paths, inserts that in each issue deal with a multidisciplinary theme, discussions focused on "cases" of legislation, critical presentations about educational policies and professional culture [24].
- *CnS – La Chimica nella Scuola*: is a national reference point for researchers in education and many chemistry teachers that can find important insights for educational activities, numerous successful experiences described in detail and possibility of update [25].

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1.7 Poland

Jagiellonian University promotes scientific development of its lecturers, students and graduates. *Niedziałki magazine* [26], edited by the staff of the Department of Chemistry Teaching, is designed for teachers of science, especially chemistry, as well as for students interested in these subjects. The aim of this quarterly journal is to promote chemistry and its achievements, information and discussion about the problems of teaching science, information about the activities of the Department of Chemistry Teaching at Jagiellonian University.

Chemia w Szkole [27] is a bimonthly journal for teachers of chemistry in all types of schools and teachers and students of chemistry pedagogy. The journal publishes: methodological proposals to facilitate the proper implementation of the new curriculum and prepare students for final examinations in chemistry and tests at the secondary school; practical tips on chemistry experiments and safety in the classroom chemistry; information about the most important achievements of chemistry in the last century; tasks along with solutions from Polish and international Olympiads chemical and national competitions chemicals for lower secondary and secondary schools; conference reports by chemistry educators, highlighting new educational initiatives; news in the publishing sector: popular books and publications appearing in international journals.

Baza Narzędzi Dydaktycznych [28] is the most tangible example of an online database of resources for both teaching and learning chemistry in Poland. It offers a variety of tasks within the subject of chemistry, physics, mathematics and humanities with comments and answer keys. The portal authors invite educators, teachers, and teacher trainers to add to the tasks discussed. The portal's main objective is to serve as a source of inspiration not only for teachers but also for students across disciplines and parents who want better education for their children ; education which is more attractive for them , awakening their imagination and ability to think independently.

The portal of the educational programme *Poczuj chemie* [29] aims to educate and stimulate a new generation of young chemists, who want to build their future on chemistry, the future in both educational and professional aspects. The keynote of the project was a spectacular side of chemistry, with not-dominant formal description. The chemical portal is the main result of the project, as interactive, dynamic, with a modern graphic design, stands out from the other solutions of this type. Of course, there are also presentations of experiences and interactive learning tools. The novelty consists in competitions with prizes (including non-virtual), often organized by the exchange of multimedia records of chemical experiences. The pioneer feature is also a formula for direct contact of schools with 'mobile' experts, 'experts on the road' who promote not only the chemistry as it is, but also through loosely related activities available through the portal [WPC]. The portal gathered many experts who interact with users on blogs and forums.

1.8 Portugal

In Portuguese context some examples of science/chemistry sources to support teaching work can be cited. Based in the Portuguese CIA network of teachers, the most relevant and used are:

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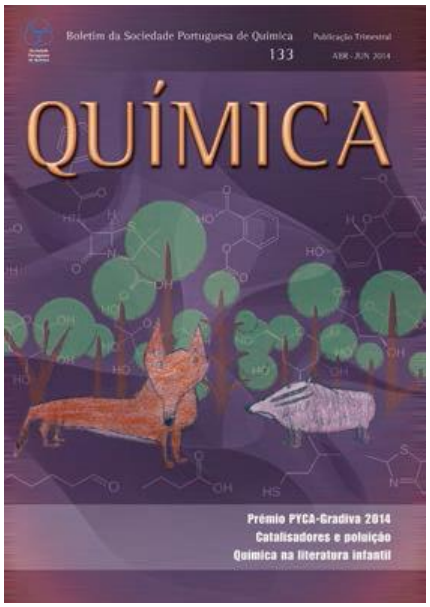
- Casa das ciências (House of sciences) [30]: this portal is a website for Science teachers, supporting teaching activities in different areas of science, and several educational levels (primary and secondary education, but also higher education). Moreover, the project is presently editing a journal “Revista de Ciência Elementar”

- A química das coisas (Chemistry of things) [31]: this project originally developed to disseminate science became very popular among teachers being their resources used mainly as motivating elements. According to teachers, the success relies on the fact of being scientifically rigorous and appellative, but short enough to not compromise the time needed to work with students.



- Boletim da Sociedade Portuguesa de Química: this is a journal edited by the Portuguese Society of Chemistry that can be found online in its webpage [32]. It includes an educational section entitled “Chemistry and teaching” and a section devoted to children “Chemistry for children”. Here teachers can found several experimental activities to implement at laboratorial classes.

- Portuguese network of Science Museums: The science museums play an important role in the creation and diffusion of scientific and technological culture. Moreover they can be explored by teachers, not only in formal visits, but also to complement classes taking advantage of the installed scientific capacity. One example of this network is the “Centro Ciência Viva” de Bragança [33].

- Educative resource section from the Portuguese Ministry of Education and Science [34]: as a complement to the educational programs, teachers can find in this website guides and materials to support their teaching activity.

1.9 Slovakia

Chemia SK [35] is a Slovak server dedicated to Slovak chemistry industry. This web page is an output of the cooperation with another web page, www.veda.sk. This project is used to develop and distribute Slovak science on the Internet through web domain www.veda.sk. Project www.chemia.sk is running because of support of the following companies: A-zet, Akronet, Lox Technologies, Visoft, and other people that are willing to dedicate their spare time for developing this web page.

The aim of the *Infovek Project* [36] (in English InfoAge Project) is to prepare the young generation in Slovakia for life in the information society of 21st century, in order to prove competent in the knowledge economy, to create the preconditions for our young generation to be competitive on the forming global labour market, especially in comparison with the young people of the same age from the European Union. School is the most important place where this transformation must take place. In order to be able to provide for this hard task, the school must change itself from a traditional school to a modern school of the third millennium through the information and communication technologies. The project concept stands on the following four pillars:

- equip every primary and secondary schools (state, church or private) in Slovakia with a multimedia classroom with high quality Internet access.
- development of a modern education curricula for general and specialised subjects at all types of schools .
- training of tens of thousands of teachers in integrating modern information and communication technologies and their application into education.

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- building information society providing Infovek classrooms to the local community for the development of the digital literacy of the inhabitants of all regions in Slovakia in the time they are not used by the school for the purpose of lifelong learning and education.

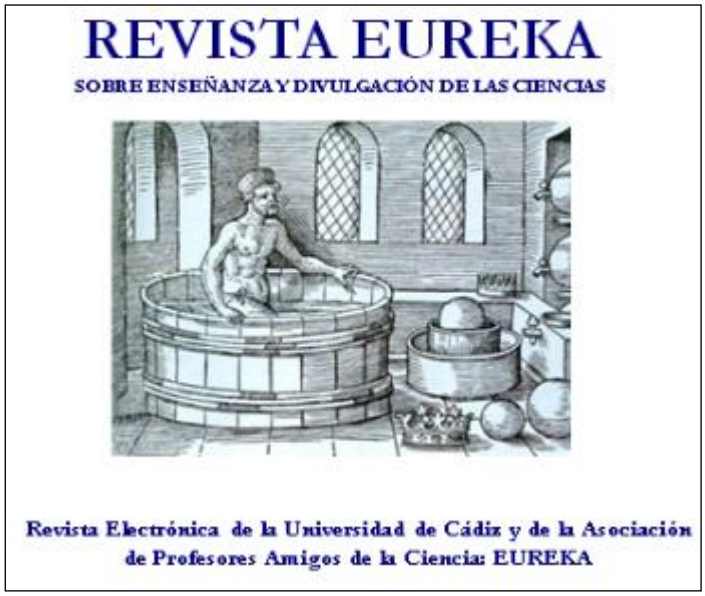
Planéta vedomostì [37] (Planet of education*)* is a complex education system which includes main topics which are educated on Slovak primary and secondary schools. Topics have digital contents in multimedia form mainly focusing on natural sciences as chemistry, physic, mathematic, biology and other natural sciences. It contains about 100 lessons in the highest quality. Each lesson includes videos, animations, interactive exercises and other activities. Structure of lessons is very flexible and it is possible to adapt them to concrete lessons and textbooks. It is possible to work with this platform in each operational system as Windows. Linux, Mc OS and with all internet systems (Internet Explorer, Safari, Opera, Mozilla Firefox.)

1.10 Spain

Enseñanza de las Ciencias (Teaching Sciences) [38], is a journal of research and educational experiences is a reference point for all the professionals of research in the teaching of mathematics and experimental sciences in Spain and Latin America since 1983. El Institut de Ciències de l'Educació de la Universitat Autònoma de Barcelona and el Vicerectorat d'Investigació de la Universitat de València, made possible the emergence of this magazine.

*Educación Química (*Chemical education) [39] is a magazine published by the National Autonomous University of Mexico and six professional associations of chemistry of Mexico spreads to all countries of Spanish-speaking, research, and educational contributions in the field of chemistry.

Aula magazine [40] is about educational innovation. In this magazine innovation are reflected in the field of education at all levels of education. It is published by editorial Grao since 1992.



Alambique magazine [41] deals with didactics of experimental sciences. It includes reflections, experiences, teaching resources and research conducted by teachers and specialists in Didactics of experimental sciences. One of the journals of reference, published by editorial Grao since 1994.

Revista Eureka [42], is about how to teach and disseminate sciences. This electronic journal of the University of Cádiz and the EUREKA Science Teachers Association, has been since 2004, contributing to the development of knowledge in the field of the teaching of science from a theoretical and applied perspective. Its two main orientations

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are: research and Foundation in teaching Sciences and educational improvement through a more stimulating and informed teaching.

Revista Electrónica de Enseñanza de las Ciencias (E-Magazine about teaching Sciences) [43] is a scientific journal dedicated to the innovation and research on the teaching and learning of experimental sciences from different educational levels. In operation since 2003. All items of educational research, educational experiences and evaluations of the same and proposals of new methodological approaches can be found to apply in the classroom. Most of the authors are professors and researchers of recognised prestige in the teaching of Sciences both at the University level and at the level of secondary education and are the main source of resources and experiences related to the implementation in the classroom teaching of experimental sciences.

1.11 Turkey

The Journal of Turkish Science Education *Türk Fen Eğitimi Dergisi* (TÜFED) [44] is published via internet one time in a year. Every volume consists of two issues. Target group of the journal is science educators and students, teachers, individuals and instructions who serve products to education sector in the journal, scientific studies are published for target group the language of the journal is English and Turkish.

Eurasian Journal of Educational Research (EJER) [45], is a peer-reviewed journal published by Anı Publisher in order to contribute to science development with discussion of new ideas, information, innovations. Journal contents cover all the sub-disciplines of education. The journal began own broadcast life when first number was published in March, 2002.

The Turkish Online Journal of Educational Technology (TOJET) [46] is a non-profit electronic journal interested in educational technology and is published four times (January, April, July and October) in a year. Presented article and research papers are published after being evaluated by the editorial board. TOJET is indexed by international broadcaster: ERIC, British Education Index, Australian Educational Index, EBSCO ONLINE and EBSCO CD ROM Database.

Theory and Practice of Educational Sciences (*Kuram ve Uygulamada Eğitim Bilimleri* - KUYEB) [47], is a peer-reviewed journal published two times (May and November) in a year. KUYEB contains all areas of education related empirical/empirical research, reviews, the most recent literature studies, meta-analysis studies, model proposals, case presentations, discussions and other original writings. Studies full text or summary take place in EBSCO and indexed by Contents Pages in Education, Educational Research Abstracts Online.

İlköğretim-online (İOO) [48] is a non-profit journal interested in educational technology that has been published four times (January, April, July and October) in a year since January, 2002. IOO is an electronic journal, only available in internet with free access. It accepts all areas of educational studies related with elementary education for publication. İOO aims to contribute to the production of knowledge about this field and to disseminate studies, theories, teaching qualifications, and any instructional design and technology about elementary education in disciplinary and / or interdisciplinary approach.

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2. Examples of successful experiences

This chapter is dedicated to report few successful experiences selected by project partners because assessed helpful to teach chemistry (or science, if primary school is considered) in a significant way, thus improving the learning and overcoming the several obstacles that pupils find when studying this subject. The identified experiences are in the form of projects, sites (or platforms, portals) providing teaching tools or journal articles describing and assessing practices performed by teachers/researchers.

One example per country is reported, but many others successful experiences are available and commented on the project portal, in the relevant section.

2.1 École Numérique

It is an initiative from several ministers, including the minister of compulsory education, which aims to fund innovative educational projects integrating ICT in schools.

The call for projects includes two axes:

1. an axis “compulsory and continuing education”, targeting “projects based on an innovative use of ICT in the educational approach”;
2. an axis “educational categories in colleges”, targeting future teachers’ initial training to implement ICT in their educational approach and to create educational contents and resources.

The selected innovative educational projects will make it possible to:

• test new educational uses supported by ICT in the context of education through skills, as it is carried out in the French-speaking Community of Belgium (“Fédération Wallonie-Bruxelles”);

• assess the relevance of using, in the context of education, a large array of technological equipment and digital resources;

• identify factors that guarantee the dissemination of educational uses and technologies on which they are based, and the means to solve possible difficulties, at the level of the French-speaking Community.

The projects submitted by schools are evaluated according to several criteria (originality, innovative aspect, benefits for students’ learning, exportability of the project, details of the project,

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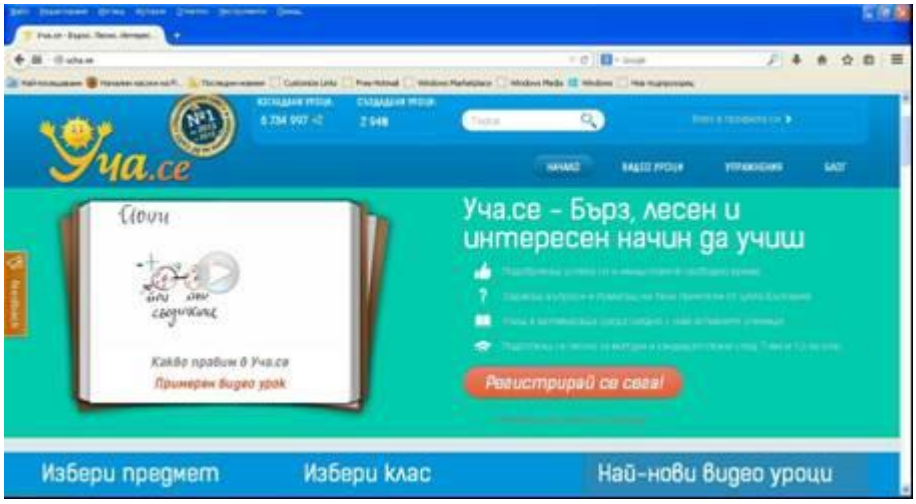
correspondence between the means and the aims). Support and training by experts are provided. The laureates in 2013-2014:
The Walloon minister of new technologies, in charge of upper education in the French-speaking Community and the minister of compulsory education approve the selection of seventy-two schools selected by a jury of experts in the framework of the second call for projects “École numérique”. All the projects concern the creation of digital educational sequences on tablet, interactive whiteboard and in network. Two schools involved in the project “Chemistry is All Around” (HELMo and Collège Sainte-Véronique) were selected to carry out sequences in chemistry: “Using the IWB and modelling to complement the experimental approach”. This sequence integrates experiments, ICT – with the Interactive Whiteboard – and the systemic approach.[49]

2.2 Educational platform Ucha.se - Chemistry video lessons



In modern pedagogical practice a big part of teachers are oriented towards the application of a number of multimedia products and interactive materials for visualization of specific problems of curriculum content in chemistry, process simulation, self-study, estimation and self-estimation of knowledge. Such an innovative product is the Chemistry lessons in the educational platform Ucha.se.
The videos interpret understandably basic Chemistry knowledge which lies in the obligatory syllabus from 7 to 10 grades. They are short – the matter is presented in 10-15 min, using also jokes, interesting stories or situations close to the students’ life. There are over 150 videos created for Chemistry. The platform users especially appreciate the video exercises where they can apply skills in solving different tasks. In the different grade sections there are lots of tests by which students can check their level of knowledge after certain unit or before forthcoming exam in school. The statistics show that users - students, university students, teachers, parents, even people of various ages find the learning from video-lessons effective and entertaining. In a one and a half year the videos have collected more than 2.5 million watches - this proves the need of such education. This way of learning has many advantages: learning from video-lessons is effective and entertaining - it’s not torturing and students learn with pleasure; the platform is very communicative – there is possibility for asking questions, commenting problems, online chatting and asking question in real time; video-lessons are particularly useful for students which absent from school and cannot study the lessons from the textbooks on their own. In the future subtitles will be inserted in the videos in order to be accessible by children with hearing impairment. The platform will offer also special forum for sharing successful

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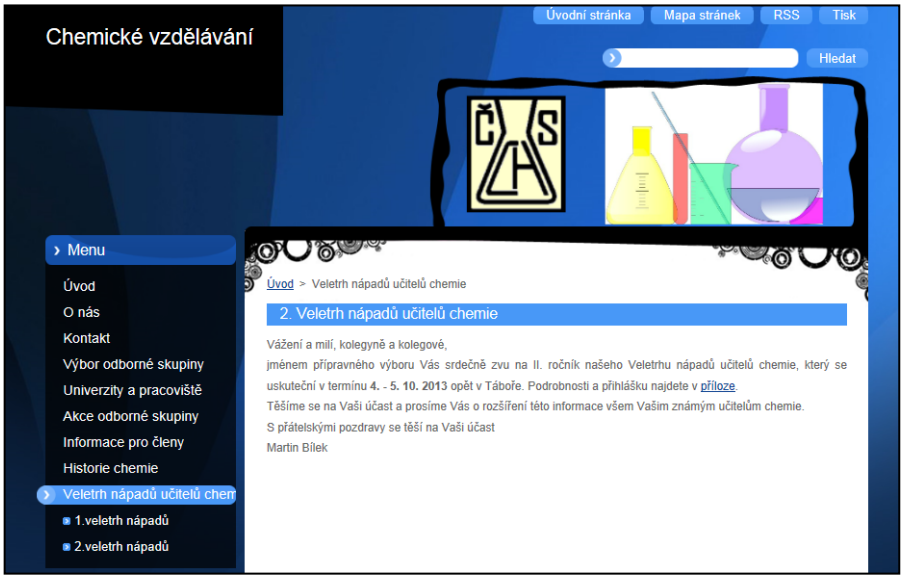
experience in teaching Chemistry (presentations, video materials etc.) of Chemistry teachers from the whole country [50].

2.3 Veletrh Napadu Ucitelu Chemie / Chemistry Teachers Inventions Fair

The fair is organized annually at high school in Tábor. Teachers themselves take part demonstrating their experiments they use when teaching. That ways they inspire each other. We consider all the participating teachers as an example of successful experience because they are motivated for lifelong chemistry activities to extend their skills and to improve their teaching of chemistry.



At the beginning of this idea was Mr. Martin Konečný, who was followed by representatives of universities. The first Chemistry Teachers Inventions Fair was held in 2012, attended by 48 teachers from different parts of the Czech Republic. Teachers were interested in the following topics: news from the field of chemistry, suggestions for experiments and how to popularize difficult topics of curriculum.
The fair consisted of two parts. Firstly, teachers took an excursion in polyester fibre factory and then in selected universities. Secondly, they spent time at Gymnázium Pierra de Coubertina in Tábor. Teachers' lectures and demonstrations were focused on practical work and experiments in schools, for example how to include experiments in teaching, how to find motivational elements, how to use domestic experiments and much more. New maturita (leaving exam at secondary schools) was also widely discussed. Teachers themselves took part demonstrating their experiments they use when teaching. That ways they inspired each other. According to the organizers, the teachers were very active and willing to cooperate. A common walk through the historical center of Tabor was surely nice enrichment for each participant.
During the two-day fair, the teachers have passed very packed program. Discussion of key problems and good practices in teaching was an important part of the fair. Since the fair was very successful, the organizers decided to repeat it in 2013 [51].

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2.4 Exploring the phenomenon of 'change of phase' of pure substances using the Microcomputer-Based-Laboratory (MBL) System

This experience aimed at helping Greek 1st grade upper secondary school students (15-16 years old) to conceptualize the relation between the molecular weight of pure substances (namely of five saturated fatty acids) and their melting-freezing points during the 'change of phase' phenomenon, by using the Microcomputer-Based Laboratory (MBL) system. The MBL system is a laboratory teaching approach which makes parallel use of computer technology. Literature has provided evidence that it can increase students' motivation and improve their "perceptions of science concepts and cognitive

skills such as observation and prediction". There was a random selection of 79 students almost exactly distributed between the two genders. Students were prompted to work in groups by using a specific worksheet in order to exchange ideas and reach conclusions while working. Students performed the actual laboratory experiment and at the same time observed the graphics registering the occurring temperature changes in real-time on the computer screen. The students had already been taught theoretically (in class) the phenomenon of 'change of phase' and the connection between the molecular weight of a pure substance and the melting – freezing point.

the data related to students' perceptions and evaluation of the teaching procedure were collected by using three different methods: videotape recordings, field notes and semi-structured interviews before, during and after the teaching intervention. After data analysis, the researchers classified the extracted student conceptions regarding the specific chemical concept under study into four different categories-types. The effectiveness of the teaching approach is measured via the students' responses into seven different questions before and after their engagement in the experimental procedure (MBL). A statistically significant increase in the percentage of correct answers was observed for all seven questions. More specifically, "after the experiment more students responded correctly to all questions concerning the freezing point of the saturated fatty acids, the relationship of the freezing point to the molecular weight and the description of this relationship". In addition, no statistically significant differences were observed between the two genders. Data analysis of the students' answers during the interviews provided clear evidence for their preference for "sensor use and computer assisted experiments over traditional lab experiments". It seems that the possibility of faster and easier acquisition of various types of laboratory data in real-time, gives students more time "to deal with the concept of the experiment" and thus they are aided to "comprehend more effectively the concepts being studied". Students' motivation to engage in the learning process seems to be stimulated [52].

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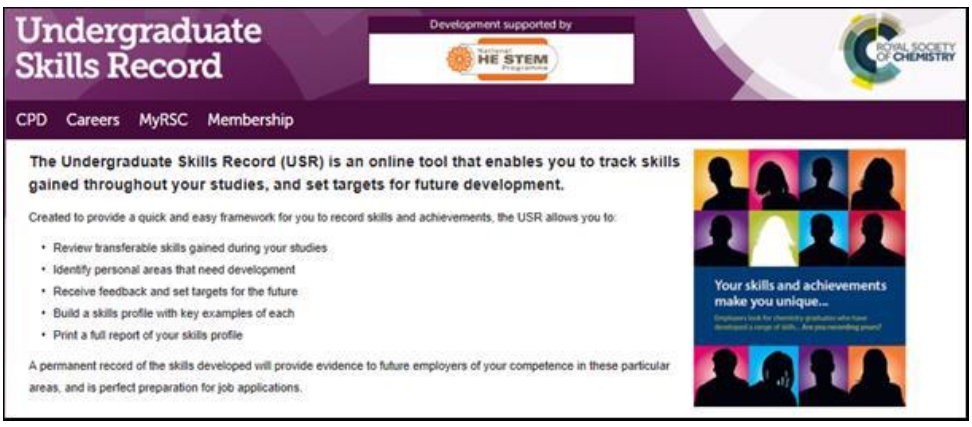
2.5 Easing the transition from secondary school to higher education through recognition of the skills of our students

It is vital that teachers at any level have some understanding of the skills levels of students. This study by Odilla Finlayson and Orla Kelly in Dublin City University developed from recognition that the transition from school to university can be daunting for many students. While students must have demonstrated a particular level of academic ability to gain entry to college science courses, their skills are rarely audited. The authors suggest that this may result in teachers placing both subject knowledge and skills demands on students. They may be assumed to have certain skills because of their degree subject choice, but in fact might not have particular skills to enable them to make progress with their subject knowledge and understanding, resulting in them making little or no progress, coupled with a feeling of frustration. The recent shift towards context and problem-based learning approaches to teaching the physical sciences may cause particular difficulties for students who have no previous experience of this type of learning as they transit from the rote-learning domination of secondary school.

The authors developed a problem-based approach which was introduced to the Year 1 chemistry laboratory module taken by students on the BSc in Science Education at Dublin City University, Ireland. To better inform the module development and enhance the skill-set of the students it was decided to carry out a skills audit of the first year students at the start of their university course. Forty four students from the 2002–2003 and 2003–2004 cohorts completed the skills survey. This identified what skills students felt they were confident in using, and which skills the students had had little opportunity to develop. The survey was adapted from the RSC's Undergraduate Skills Record (USR).[24] Various skills were identified in the USR which were seen to be important for first year undergraduate students, such as interpretation of laboratory measurements and observations and using feedback to improve on future work.

Examples of interventions developed for the Problem-based Learning module include: incorporating oral (PowerPoint) presentations into the laboratories; getting students involved with the development of experiments by researching appropriate techniques and procedures using the internet and other resources; the importance of errors and evaluating experimental data was a key focus of laboratory reports and their presentations. This was done in a gradual way, increasing the skill demand across the year-long module. The qualitative result of the trial was that the students seemed to develop skills in the manner anticipated. The authors conclude that more innovative science curricula are needed at school level science to ensure that future science undergraduates will enter courses with more developed skills. A move away from the didactic to a student-centred approach at secondary level Chemistry might encourage better skill development and more confidence to study Chemistry at undergraduate level [53].



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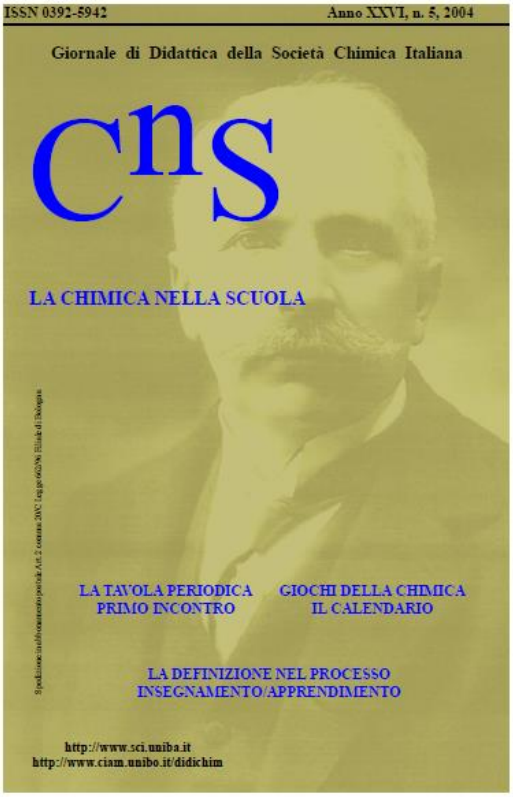
The Undergraduate Skills Record (USR) is now available on-line [54] in an electronic format that allows students to create an account and record and save their skills continuously, set goals and future targets and generate a skills report at any point.

2.6 First approach to the periodic table of elements. A historical-epistemological approach to the teaching of chemistry

It is frequently suggested that the history of chemistry can be used in teaching the subject on the account of supposed parallels between the learning process and the development of science. This idea is put into practice in the teaching sequence described in this paper, aimed at bringing high school students to build up the foundations of the periodic table of the elements. Learning situations are based on thought provoking problems concerning the macroscopic properties of simple substances: to answer these questions, students may refer to the same information used by Mendeleev to build up the principle of periodicity. The learning situations bring the students to deal also with two important chemical concepts: those of simple substance and element which are frequently confused in teaching.



The sequence presented in this article has been tested over several years in several classes and essentially aims to bring students to "rebuild" the backbone of the periodic table, reasoning on the same chemical information that was available to Mendeleev: the atomic weights of the elements and the physical and chemical properties of some simple substances and compounds. The historical approach has the advantage of making students retrace the intellectual path of Mendeleev, highlighting the difficulties and the various hypotheses that were subsequently deemed acceptable or rejected.

As a first activity, each student is provided with a sheet of paper format A21 and a set of nineteen cards on the following elements: potassium, hydrogen, lithium, boron, beryllium, magnesium, aluminum, bromine, chlorine, sulphur, sodium, calcium, silicon, oxygen, fluorine, arsenic, carbon, nitrogen, phosphorus. Then, the following delivery is assigned: “order, in the way you think more appropriate, the cards you received, pasting them on the sheet of paper. On the same sheet, write, in order of importance, the criteria used to order the cards”.

The subsequent activities, which are described in detail in the publication, aim to improve the first draft of the periodic table built by the students, using new information, the guidance of the teacher, the work in small groups and the comparison between the different views.

Finally, the inclusion of new elements in this periodic table leads to verify the criterion used to sort the elements and to discover the concept of periodicity.

The approach described in the paper was readily accepted by most of the students, who become involved by problematic questions which require them to think, reflect, reason, make predictions and draw conclusions.

Offering students the opportunity to work in first person to the development of the structure of the periodic table, as Mendeleev did, allowed them to build the concept of periodicity in the operating

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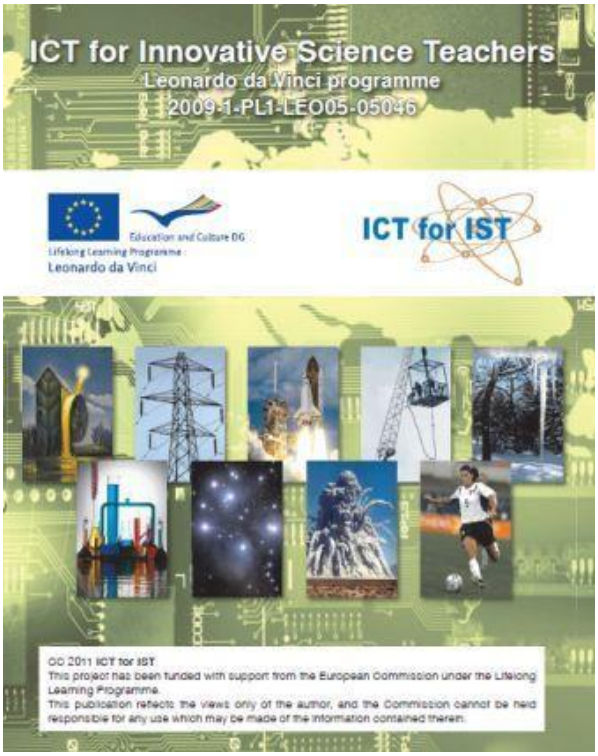
mode, as a result of a personal path to the knowledge.
From the point of view of science education, the historical setting is much more educational than the traditional one, in which knowledge is systematized and where you forget all the attempts of other scientists, the different approaches and the first inconsistencies.
The specific disciplinary knowledge and the learning objectives have been achieved in a satisfactory way [55].

2.7 Projekt ICT for IST, czyli jak nowocześnie nauczać fizyki, chemii i biologii/ICT for Innovative Science Teachers



The Centre for Education and Information Technology in Warsaw coordinates the project ICT for IST (ICT for Innovative Science Teachers), the Information and Communication Technologies for innovative science teachers, implemented within the framework of the program "Lifelong learning Programme ', Leonardo da Vinci Transfer of Innovation. The project developed a package of ICT for IST - a set of teaching materials to assist the teaching of modern physics, chemistry and biology in upper secondary schools. It consists of thematic modules (motion and force , vibration , jumping on a rope , cool down and change of state , Electricity , diffraction , photosynthesis and respiration , energy and the human body , strong and weak acids, chemical reactions) , video tutorials and software. Each module contains methodological materials for teacher and student exercises for data-logging , videomeasurements and modeling. Classes are planned so that the use of information and communication technologies gave the benefit of education, supported the understanding of natural phenomena . Most developed exercise is best done in an environment Coach 6 and Insight (there are Polish language versions of these programs) . You can use the free modeling software (eg Vensim , Modellus) or carry out the experiment on-line Internet (module Diffraction) . The package includes a free browser with a set of simulation technologies (ICT for IST Simulation Insight Player) , illustrating the phenomena discussed in thematic modules .
These materials were tested during the pilot training (classroom and on-line learning platforms) for science teachers in all partner countries and in the classroom open for students and teachers of secondary schools in Poland, Austria and the Czech Republic. The teachers and methodologists who participated in training at the Centre for Education and Information Technology in Warsaw appreciated the usefulness of ICT for IST Package in science education both in high schools and in vocational education [56].

2. 8 Casa das Ciências/House of Sciences

Casa das Ciências, a project sponsored by Fundação Calouste Gulbenkian (Calouste Gulbenkian Foundation), is a website for Science teachers that promote the use of information technologies (ICT)

in the educational process. It supports teaching activities in different areas of science and several educational levels (primary and secondary education, but also higher education). The site is gradually becoming a portal "from teachers to teachers" being a space where they can find useful and effective materials for their professional activity. It is a place where they can exchange ideas about the materials and the way they can be used. In conclusion it is a space for sharing experiences.
All the materials available on the portal or recommended by it are firstly evaluated from a scientific and educational point of view, according to a peer review methodology. Currently, the acceptance by the Editorial Board and subsequent publication is recognized as prestigious, in analogy with the usual scientific publications. The portal has over 12,600 registered members with a Portuguese science teacher's penetration rate exceeding 30%. With over 4 million cumulative views in all of its components, the global daily demand is up to 3-4 thousand visitors, with a significant impact (some components above 40 %) from other Portuguese speaking countries [57].
The portal also includes a wiki section, the Wikiciências and an image bank. Moreover, the project is presently editing "Revista de Ciência Elementar" [58].

2.9 Chemistry and cooking: from context to building models

Using kitchens as household laboratories is one of the most widely used resources in class in order to connect chemistry with everyday life, by carrying out activities such as preparing recipes, using food or cleaning products as reagents, etc. This article looks at the advantages of using chemical phenomena in cooking to go beyond increasing students' observational field and offering opportunities to use models to help explain the phenomena observed and make predictions. It also describes a proposal for first-year secondary students in which students not only observe, but also increase their ability to explain what happened using an historical acid-base model.
The importance of developing models that allow observable phenomena to be explained is explored and relevant supporting literature is cited. Historical interpretation of acid-base reactions developed by Lemery was selected for use as a suitable model to allow the students to explain and predict the processes they will study. This model proposes that acids and bases differ in the shape of their atoms and is applied very effectively to allow students to explain and predict a series of observations.

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In the study, the following processes were examined by students;

1. Reaction of vinegar and sodium bicarbonate and the inflation of a balloon with the resulting gas produced,
2. Use of broth and cabbage indicator to determine if a range of food and cleaning products were acids or bases,
3. Addition of some deionised water to some vinegar and indicator,
4. Addition of some ammonia to vinegar and indicator gradually to change the solution to neutral and then to basic.

Students were asked to draw the system before and after the materials were mixed for stages 1, 3 and 4. Examples of these drawings are provided and discussed and those produced for stages 3 and 4 are particularly impressive [59].

2.10 Activity approaches by teaching chemistry - prove pedagogical experience from educational practise

The publication is divided in two parts. First part is about description of effective pedagogical experiences with a list of key competences which should be reached by the class. The second part is about individual activity approaches described in detail. Activities are:

a) Work with text – searching information about concrete topics without introductory explanation or searching refill information from publications, from internet and transformation to presentations, posters, papers, banners, etc.

b) Working in groups with various innovative methods – role plays, carousel, etc.

c) Students mini-conferences about concrete topics

d) Individual projects or group in form of monthly or yearly students work.

e) Home laboratory experiments prepared by students and presented in class in front of other students or home presentation in form of photo or video.

f) Students' laboratory experiments realised directly as chemistry lessons, relating to procedures from chemistry textbooks or other chemistry publications

g) Creation of chemistry non-typical forms of outputs for chemistry lessons:

- graphics (concept maps, drawing jokes, graphs, diagrams)
- literary (protocols for laboratory experiments in forma of poems, fairy tales, riddles, epigrams, crosswords, brain teasers, etc.)
- tools produced by students

The main objective was to provide educational material and show that chemistry can contribute to the development of reading literacy and that students can learn independently. That students can obtain the necessary information related to chemical problems from different information sources (professional literature , Internet) and use multimedia teaching materials . Teaching chemistry using active learning methods, contributes significantly to the formation and development of logical, critical and creative thinking of students, as well as the adoption of important manual skills [60].

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2.11 Proje destekli kimya laboratuvarı uygulamalarının bazı bilişsel ve duyuşsal alan bileşenlerine etkisi

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Proje Destekli Kimya Laboratuvarı Uygulamalarının Bazı Bilişsel ve Duyuşsal Alan Bileşenlerine Etkisi

İnci MORGİL[1], Hatice GÜNGÖR SEYHAN[2], Nilgün SEÇKEN[3]

The authors' main aim in this article is to illustrate the results of a research conducted about why the students are responsible for their own learning process and they cooperate with other students in learning. And it gives some information about a group of students who enters to the laboratory and sees concrete things ,and they learn by experiencing. It show it has a positive effect on the students' skills of thinking and commenting.

In the introduction part, the paper show some reasons as to why activities which are conducted in the laboratories have an important role in the Science curriculum by stating that it provides many benefits. It also presents that there are different approaches and thoughts about the laboratory and the aims of the laboratory activities in their education of Science. It also illustrate the place and the importance of laboratory in Science Education. What it tells about the main aim of the activity is that It enables an environment which enables an environment where they can produce their own information. The students enhanced their skills of questioning, creating hypotheses.

In another paragraph which give information about the methods, the authors show some methods which were used in experiments such as exemplification, the means of gathering data, the scale of approach towards Chemistry, the scale of approach towards Chemistry Laboratory, Anxiety Orientation-Motivation Questionnaire, Test of skills of Scientific application, the problems encountered in the laboratories and lastly, the interviews with teacher candidates. It also gives some information

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about some implementations which are carried out the research and the list of the experiments which are carried out.

At the findings paragraph the author mentions that they aim to illustrate that prior to and after the experimental applications, experiments are conducted with the teacher candidates' KTÖ, KLTÖ, KO-MA and BİBT front-back scores by analyzing the final performances of teacher candidates and the data which are learned from LKGA.

Under the discussion and the recommendation paragraph, the authors states that the approach based on the projects is a model in which there are no short practices during the class and the learning activities which are different from the teacher centered classes and which are adapted to instead multidisciplinal, student centered and the real topics and experiences from the world and which emphasize the in-class learning activities. After their discussions, the authors end the paper with their recommendations within the framework of the research [61].

3. The impact of the project on successful experiences

The work of this third and last year has been particularly challenging for everyone involved because it allowed to work in concrete way on tools to teach chemistry and to experiment with students, who are the end beneficiaries.

As every year, the workshop enabled many teachers to meet and share experiences and concerns, and to get valuable tips from the experts.

The most important innovation of this year was not planned initially as a project activity. It was designed and introduced in order to reinforce the objectives and the project impact on school environment and to enrich the portal with attractive and useful material for teachers.

Following the promoter proposal, during the partners' meeting held in Limerick (27-28 November 2013) all partners agreed that it is necessary to test ICT teaching resources in classroom and in structured way. So, the teachers involved chose and used some portal resources with their students, then producing reports. These reports, uploaded on the new portal section called "testing", contain testimonials and suggestions for educational paths that can be followed and supported by the above tools, tips and considerations from teachers. In particular, the report structure is the following:

- teacher name, affiliation, role in the project
- topics related to the resource
- examples of learning objectives
- practical information regarding the use of the site/simulation.
- information about the class that was involved in the testing
- suggestion for use (how the resource was used and possible alternatives about how the resource can be used)
- considerations about the resource (insights into student use / thinking, teacher's conclusions)
- supporting info (es. worksheets produced by the teacher, if available)

In the paragraph 3.2 one example of testing experience per partner is reported and briefly discussed. Many other reports of testing were uploaded on the project portal in the relevant section: *Teaching Resources → Testing*

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3.1 Sharing successful experiences in a local context: the national workshops

The most important opportunity to meet for teachers and experts is during the annual workshop. In this case the attendance is large and the discussion is engaging. The workshop is fundamental part of the project because it allows to:

- share and integrate the work that experts and teachers make for the project
- discuss and compare problems and experiences in order to improve everyone skills

The last workshops, held in May 2013, dealt with teacher training and the general agenda consisted of the following points:

1. Presentation of national activities born to support CIAA_NET objectives
2. Focus on teachers' and experts' personal successful experiences
3. Discussion on teaching resources tested at national level
4. Planning of future work

Each country performed the workshop with great commitment and involvement because the topic of successful experiences is very concrete and belongs to the everyday work of each teacher. Points 2 and 3 were the most discussed, in some cases involving teachers and experts in a round table, in others as individual presentations, in others dividing the participants in small groups and giving them successful experiences to discuss, adapt or design.

In any case, national successful experiences were critically analyzed and taken as example, as well as experiences selected in other countries and uploaded on the project portal. Also personal practices experienced by teacher were shared, assessing positive and negative aspects and performing improvements with the aid of the experts.

Special emphasis was given to the use of ICTs in the teaching of chemistry. National and international good practices were analyzed and time was dedicated to present and discuss the results of testing of some ICT teaching resources selected during the first year of project.

Detailed information about each single workshop are given in the relevant minutes, available on the project portal.

This activity gave, as every year, satisfying results. Teachers felt particularly motivated and interacted with great benefit with colleagues and experts to improve their teaching methodology with the aim of leading students to be more motivated and to develop competences.

Belgian workshop

Bulgarian workshop

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UNIVERSITÀ DEGLI STUDI DI GENOVA

CHEMISTRY IS ALL AROUND NETWORK

518300-LLP-2011-IT-COMENIUS-CNW

Czech workshop

Greek workshop

Spanish workshop

Irish workshop

Italian workshop

Polish workshop

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Portuguese workshop


Turkish workshop

3.2 Setting new successful experiences: testing of ICT teaching resources

Découverte de la réaction chimique/Discovering the chemical reaction [62]
Tested by Belgium

The resource “Discovering the Chemical Reaction” was tested at Haute École Libre Mosane (HELMo) in Liège, with twenty-two first year students (future science teachers). It is a learning sequence that favours the experimental and systemic approach of the chemical reaction. Therefore, the activities (laboratory, observations of phenomena, modelling) are organised so as to facilitate a progressive gradation of abstraction levels (from the macroscopic to the microscopic levels). The interactive whiteboard is used as an open and interactive written support all along the sequence. The varied ICT resources integrated on this support makes the modelling of the phenomena, and thus transition to abstraction, easier. Since the resource is addressed to a secondary school audience, those students did not learn much, the focus was on how to use the resource with younger students.

Students could provide their feedback through a questionnaire on the learning platform Moodle. When asked what they learn, most students answered how to use the interactive whiteboard, or further applications of the IWB. While the sequence is addressed to younger students, several students who tested it said it helped them refresh some notions related to the chemical reactions. Students considered the sequence was well organised and stimulating, and could help understand the topic. Those learning were built especially during the oral presentations in group supported by the IWB. According to them, learning is made easier by experimentation and the use of ICT. Mentioned obstacles to learning concern modelling during hypotheses. Besides, during knowledge consolidation exercises, some students had difficulties to analyse everyday life examples.

Teacher’s conclusion

According to those first experimentations, based on a limited number of students, the following temporary conclusions can be drawn:

a) Regarding the creation of learning scenarios integrating ICT:

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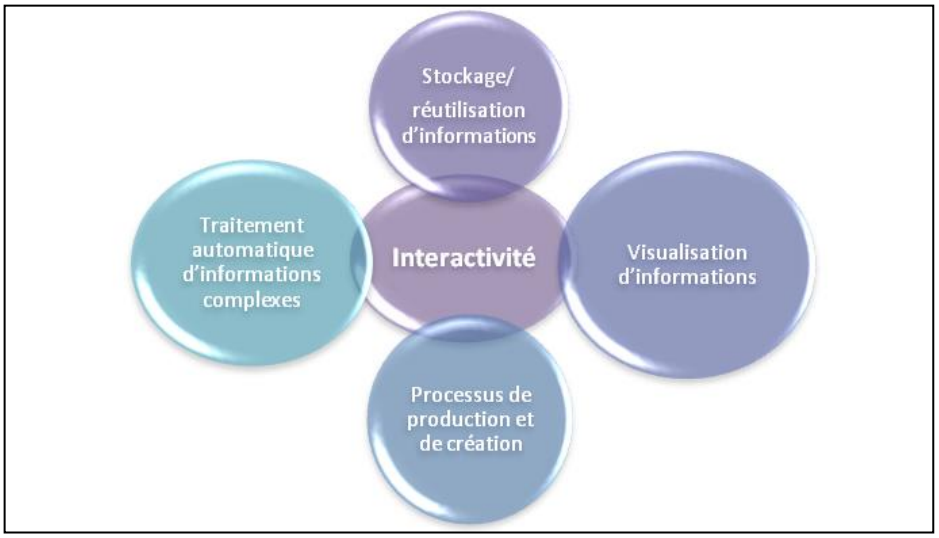
To foster chemistry learning, learning scenarios should specifically integrate ICT (videos, animations, IWB…) to support the investigative approach for a gradation of abstraction levels. Those learning scenarios would help develop scientific, technical and transversal skills.
In the experimented learning scenario, ICT resources, integrated in the IWB, are mainly used:
• In the beginning during the phases of questioning and common gathering of students' hypotheses,
• At the end for structuration and knowledge consolidation.
However, depending on the topics, ICT can be used at other moments of the process. Without replacing real experimentation, ICT can support the investigative approach at different moments of the process. Indeed, the main asset of ICT to support the investigative approach is the improved analyses of complex dynamic phenomena at the macroscopic level (with videos) and their modelling at the atomic and molecular levels (flash animations or others) to make the transition from the macroscopic to the microscopic level easier.
ICT integrated to the IWB have other assets to support the investigative approach.
b) Regarding the assets of the IWB:
The assets of the IWB are presented in relation to the investigative approach. The four main categories are built on a student-centred educational approach.
The diagram below shows the most specific asset of the IWB, in the centre, interactivity, to which other assets, to be moderated, can be added: information stocking and use; information visualisation; production and creation process; automatic processing of complex information.



Chemgeneration [63]
Tested by Bulgaria
It was tested at Vocational High School of Electronics – V. Tarnovo (9th grade, 18 students, ICTs education) and Private specialized High School "American Arcus College" – V. Tarnovo (9th grade, 18 students) by chemistry teachers Galina Kirova and Jenna Staykova. This resource helps the understanding of the concept of sustainable development through the use of self-browsing Internet sources to provoke environmental awareness. It enlarges the basic knowledge, allows integration of science in educational content and visualization of 3-dimensional structures and combines learning with entertainment.
The resource was used as follows:

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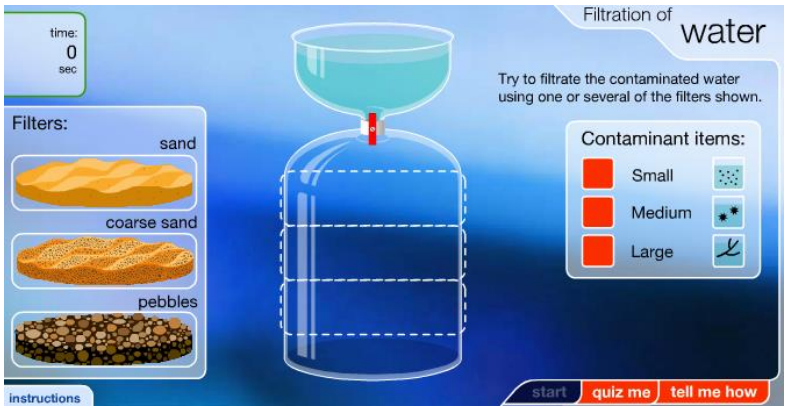
1. Presentation of the case to all participants in the group. Detailed study of the case and defining the basic problem.
2. Analysis of the proposed Internet resources related to the topic of the case. Group discussion and decision-making. Developing of intellectual map of the pros and cons of the decision.
3. Reports before all groups of analysis that each group had made of their case.
4. Discussion in the common group and debating over possible solutions and alternative opinions.

The most liked are electronically presented animated models and varied interesting information. The resource ensures utilization and interpretation of educational content by stimulating the student's cognitive activity; it provide the student with motivation and willingness to learn.

Chemistry and Water Treatment [64]

Tested by Czech Republic



Mrs. Pavlína Jiroušková is the science teacher at Lauder school of Prague that tested the resource. The resource was used to obtain ideas and information for small groups of students. Outcomes of using the resource were interactive models, papers, posters and many more. Mixed age group of eight students (lower high school) worked together as an educational group. Older students cooperated with younger ones. They worked as a real team for four days in the following way:

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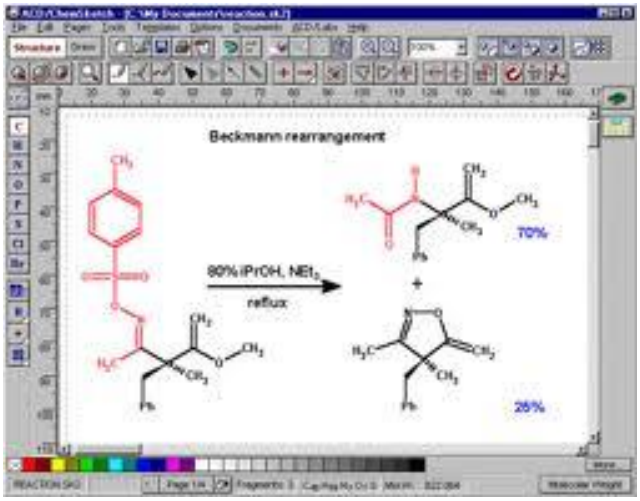
1. Students learned about water and environment. They used some textbooks and ICT and they learned together in an educational group with their chemistry teacher.
2. Students used resources on *Chemistry Is All Around Network* portal and chose the most related resources to their topic.
3. Together with their teacher, they learned characteristics of the water, structures, reactions and water treatment and used the resource named *Chemistry and Water Treatment*. They discussed animation demonstrating water filtration.
4. They created a real model that can filter coloured water to clear water. They used PET bottles, sand and other needs for that.

5. Students prepared a show for their schoolmates. During the show they explained principles of water filtration and added some posters and banners. They also explained structure and some chemical properties of water, and showed how water purifier works. The presentation was involved in the whole-school project named *So that there is no deluge after us*. The school project was presented in Korunní Theatre at Prague (http://www.divadlokorunni.cz/). Approximately 12 groups of students presented their outcomes there (not just the chemistry leisure club). The main topics of all the students groups were recycling, ecology, green architecture and so on. About 150 children were present in the auditorium of the theatre; there were students, their teachers and parents.
Students were very active and inquisitive. They cooperated together very well and prepared useful models of water filtration. It was motivating to use a resource in English but it was problematic too. The teacher did not speak English but students and other teachers helped her with translation.

Chemsketch 12 Software [65]

Tested by Greece



The testing was conducted in 1st grade (15-16 years old) upper secondary school students. This teaching resource is related with basic organic chemistry topics such as structure of organic compounds, organic nomenclature, stereochemistry and functional groups. The learning objectives involved drawing different types of formulas of organic compounds, alkanes' nomenclature, studying of the tetrahedral carbon atom structure in alkanes and of the ring structure in single-ring cycloalkanes. In order to make the students

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realize the usefulness of this software in understanding organic chemistry topics, each one of them (21 students in total) worked separately with his/her own computer (ca. 30 % of the students brought their own personal PC due to the limited number of terminals at the school's computer lab). In addition, a worksheet - prepared independently by the teacher involved – was necessary for successful implementation which is translated to achievement of the learning goals and coverage of the need for a manual in the Greek language.

The level of knowledge as well the students' attitudes related to the use of simulations and other ICT based applications in natural science lessons, were evaluated before and after the testing of the teaching resource, via the use of a questionnaire designed by the teacher. The main findings related to the effectiveness of the specific teaching resource are the following: i) students found the drawing of 3D chemical structures both interesting and amusing, ii) students managed to derive logical assumptions correlating chemical structure (microscopic level) with chemical reactivity (macroscopic behaviour) [namely correlation of cycloalkane's ring strain with heat of combustion values], iii) students successfully employed the software in order to derive the names of the organic molecules under study and at the same time evaluate their own knowledge in organic nomenclature.

The main results related with the student's opinion on this resource are the following: i) the large majority (ca. 80%) found the resource "extremely interesting" while the rest 20% found it simply "interesting", ii) all students found the software user friendly, iii) all of them (but not to the same degree) intend to employ "ChemSketch" in the future in order to study the stereochemistry of chemical/biochemical compounds, iv) a large proportion of the students (ca. 50%) would prefer to only be exposed to the resource but not to use such type of non-standard teaching approaches systematically in class, because they fear that in this way they will not have time to study in depth and learn well the vast amount of material they will be tested on in the final national exams for entering tertiary education institutions.

From the above it is concluded that taking into account the special characteristics of the Greek educational framework and environment, this teaching experience is evaluated positively.

Chemistry Experiment Simulations and Conceptual Computer Animations (Acid-Base titration) [66]

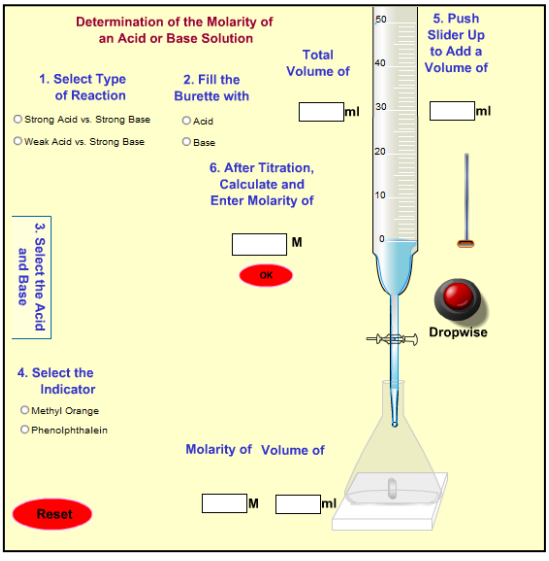
Tested by Ireland

The resource is a simulation tested on 9 students in an upper secondary school class.

It is ideal for revising after lab work has been completed and then later, for exam preparation.

Also suitable to allow students to try many examples on their own where further consolidation/practice is needed.

Some of the students found this resource very useful for revising, but some found it too time-consuming. They liked the instant feedback about whether or not they were correct in their calculations.



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Educazione alimentare/Food Education [67]

Tested by Italy

This resource is a site that provides numerous explicative texts dealing with different subjects (food, nutrients, hygiene, food labels....) and an interactive section (games) that enables the user to evaluate his skills or the effectiveness of the learning. Each game allows to get immediately the feedback and, if necessary, to go back to the related explicative text.

It was tested by Ilaria Rebella at the primary school of Comprehensive Institute Savona 4. She worked with a class of the second year (pupils 7 years old) by organizing a scientific 'treasure hunt' in the following way:

- the class was divided into groups of two or three pupils
- the teacher proposed open questions about nutrients, to be answered by consulting the site
- the teacher proposed a final question connected with the previous open questions
- who finished the job could play games about the nutrients present on the site
- at the end groups shared answers and comments

Worksheets to fill in during the treasure hunt were produced by the teacher with the treasure hunt generator site (http://www.aula21.net/cazas/cacce.htm), as reported in the example uploaded in the supporting info section.

Pupils performed the task with pleasure, as if it were a game, but also very seriously, trying to get the highest score looking for all the elements necessary to answer the final question.

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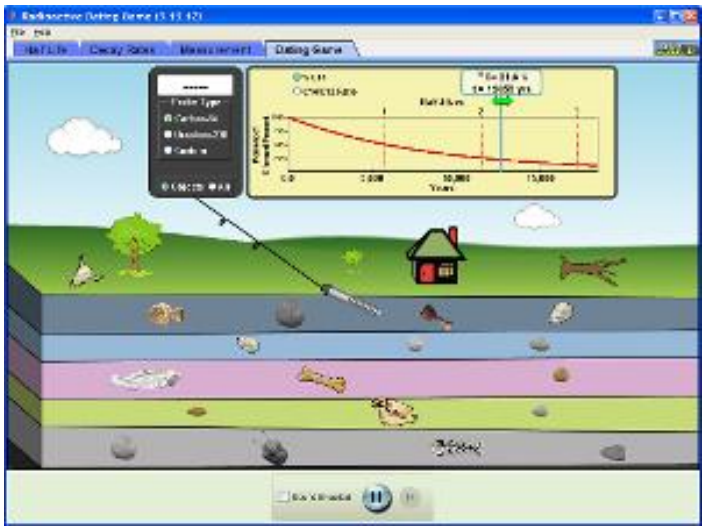
Navigating the site was easy also for very young pupils, but sometimes the teacher had to mediate some of the concepts unknown to so young students, as "cells", "plastic function", "enzymes" and so on, however they focused the main nutrients and principles of food education. They showed good cooperative attitudes.
The resource provided interesting insights to undertake a path of reflection on the food pyramid and a proper diet with local seasonal foods.

Radioactivity: beta decay, alpha decay and radioactive dating
Tested by Portugal



The following tested digital resources where extracted from the portal *Phet*:
Alfa decay [68]
Beta decay [69]
Radioactive dating game [70]
The activity was performed by a chemistry teacher using two classes of 90 minutes each, and having 30 students with an average age of 17 years old
A methodology supported by the use of a learning guide was used. Learning guides are mediation tools created to support the exploration of the software and guide students during their learning process by helping them to organize and structure knowledge in a global and transversal way. In that way, students will use computers and educational software to interact with scientific models by changing data and variables, engaging in the exploration of the physical situation, persisting in performing the task, showing initiative, taking control of their actions by making proposals, formulating new questions and managing to involve other students in task accomplishment and exploring the situation.
The competences and the learning results acquired by students were evaluated through the application of pre- and post-tests, i.e., tests applied before and after the classes. The evaluation of the performed tests pointed out for a normalized gain of 0.64.
The students' opinion about the used digital resource was collected by means of questionnaires. A vast majority of students (>90%) found the digital resources used interesting and more efficient than books, considering that they promoted the interaction with a fellow student, centering the discussion on chemistry themes. 70.8% thought that the resources used facilitated their understanding of the studied concepts. Evidence gathered suggests that the use of digital resources mediated by the teacher and by learning guides can enhance significant learning.

Iniciación interactiva a la materia/Interactive introduction to the matter [71]
Tested by Spain
Antonio Jesús Torres Gil tested this resource with 30 students from 1º Bachillerato (16-17 of age) in the subject Physics and Chemistry. The Topics related to the resource are: behavior of matter, atomic models of Thomson, Rutherford, Bohr, atomic an nuclear structure.

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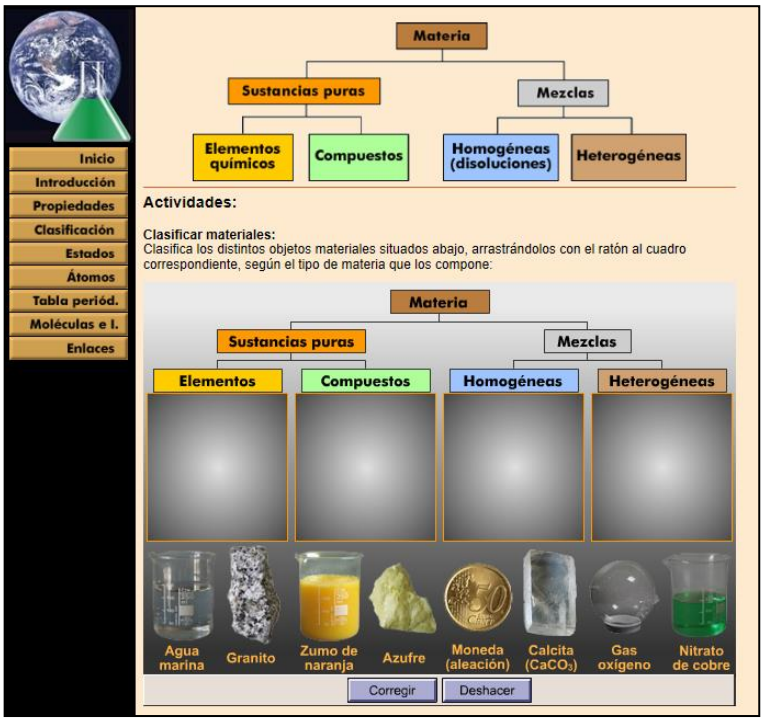
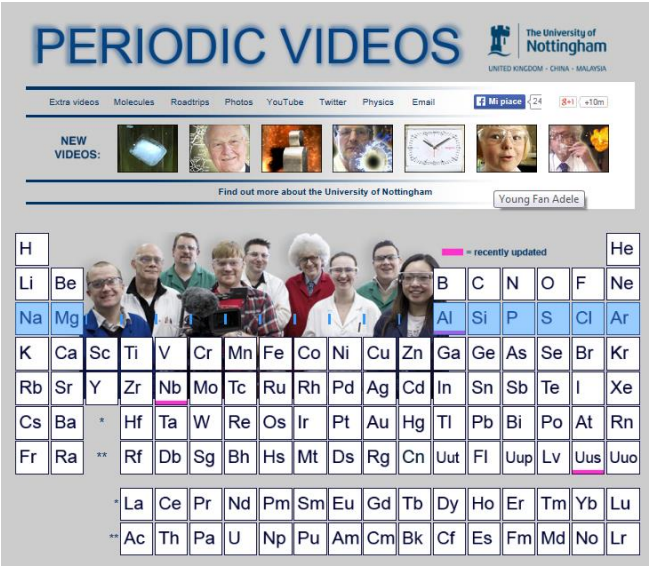


Students studied the didactic unit "the atom", using the resource. Then they worked interactive exercises that appear in the website. The students used their Ipads during the learning sessions. The activity was very well received by the students, who very positively evaluated their work in this unit.

This resource enhances motivation and competences of students and develops a historical perspective of science

www.periodicvideos.com [72]

Tested by Slovak Republic



The resource was tested at the vocational secondary school in Krupina, with 13 students in age about 15 years old. It was selected as basic starting point for these students in order to show them the periodic table and the chemistry of elements.

Before starting to explore the resource, the teacher briefly introduced students about the periodic table of elements and about how the web page works. Then students, in small groups, experienced autonomously the site watching few videos, selected on the basis of their curiosity.

Eventually, teacher explained the most significant videos, also in terms of chemical reaction, stimulating students' deductions and observations. So, the chemistry of hydrogen, oxygen, iron, copper, aluminium, silicon, phosphorus, chlorine , argon, magnesium and sodium was discussed.

Students showed intense interest during watching the videos. They asked several questions that triggered further discussion and offered the opportunity for knowledge expansion. They also participated with a lot of enthusiasm and were very satisfied of this new approach to chemistry.

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3DMolSym (Molecular Symmetry) [73]

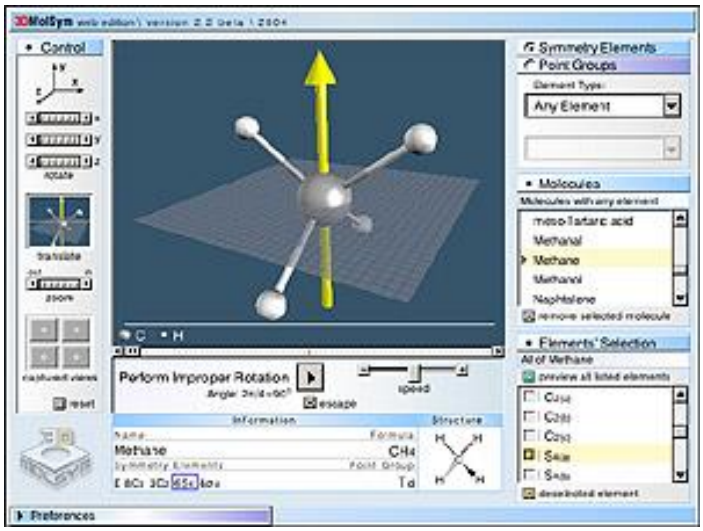
Tested by Turkey

The resource was tested by a workgroup of 18 teacher candidates, attending the science teacher training courses at the department of Kırıkkale University.

The testing was carried out mainly in the following steps:

- firstly, teachers are given information about the work to be done
- the 3D simulation program is examined: 5 open-ended questions were prepared as assessing tool
- the questions were proposed to students as a pre-test
- then, the 3D simulation software and applications were used: some formula of molecules, bond structure and symmetry properties were investigated and students had the opportunity to practice them in their computers
- at the end of the study, the assessment tool was applied as a post test.

When the results of the tests were analyzed, it was clear that 3D applications had yielded positive results in building molecule formulas, drawing bond structures and drawing symmetry.



Students' remarks about the resource were the followings:

- it reminds old information
- It is useful for chemistry teaching
- it embodies issues
- it visualizes issues
- it provides practicality
- it facilitate the understanding
- it provides permanent learning
- it shows false clearly
- it provides feedback

3.3 Sharing successful experiences in an international context: the conferences

The international conference *Successful Experiences and Good Practices in Chemistry Education* took place in Bragança on 21th May 2014 at Escola Superior de Tecnologia e Gestão do Instituto Politécnico de Bragança. The aim of the conference was to share European experiences on successful strategies, initiatives and projects to promote chemistry lifelong learning.

The Conference was a one-day event with the morning session centred around the European experiences collected through the Chemistry is All Around Network project, and the afternoon devoted to other contributions, namely the ones from the Portuguese Scientific experts integrating the Chemistry is All Around Network project.

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In addition to the oral session, one poster presentation and one exposition comprising the results of several Portuguese science communication/dissemination projects were organized. The compositions of the organizing and scientific committees, as well as the conference programme are available on the conference web site [74].

Around 100 participants registered from a number of European countries, with the largest representation from Portugal. These included representatives from universities, schools, educational companies and public authorities. It was an opportunity to consolidate the work of the Chemistry is "All Around Network" project. Furthermore, it allowed associate partners and experts from Portugal to meet the European partners. The model of mixing oral and poster communications with practical workshops was very positive bringing dynamism and fomenting an active discussion between participants.

The International Conference *Successful Educational Experiences and Didactic Guidelines in Science Teaching* will be held at the Department of Chemistry and Industrial Chemistry of Genoa (Italy) on October 23rd and 24th 2014.

The aim of the conference is to present the work done by experts, teachers and students of primary, middle and high school in eleven different countries: Belgium, Bulgaria, Czech Republic, Greece, Ireland, Italy, Poland, Portugal, Slovak Republic, Spain and Turkey.

The conference is not only addressed to scientific experts in chemistry and school teachers, but it is open to all people interested in scientific training.

4. Conclusions

The last year of the project was the most interesting and engaging, especially for teachers.

The theme of the successful experiences involved teachers in research and evaluation of tools to use with students. They could present their experiences and compare them with those of colleagues, thanks to the national workshops; here, the discussion with experts revealed strengths and weaknesses in the teaching of each one, gave new ideas for improvement and strengthened collaborations.

The testing of some ICT resources, chosen among those uploaded on the portal database, gave further substance to the project, reinforcing the objectives and the impact on schools.

We believe that the rich database of successful experiences and of ICT resources, that were the subject of intense work by qualified teams from different countries, is very significant nowadays, for all those who deal of science education in Europe.

In 2000, the European Union started a process well known as the "Lisbon Strategy": it is a system of reforms that spans all fields of economic policy, but its main characteristic is that for the first time the themes of knowledge are identified as fundamental. Subsequently, in 2006, the European Parliament and the Council invited the Member States to develop, as part of their educational policies, strategies aimed to grow in young students the eight key competences that may constitute a basis for further learning and a solid preparation for adult and working life.

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In this new panorama, the achievement of scientific literacy and development of key competences of students become one of the main objectives in natural sciences and particularly chemistry training.
This led to the urgent need to change the teaching methodology, to resort to new and more appropriate educational tools and to design, collaborating vertically.
This is a long process which quality and final results are influenced by factors as quality of educational plans and curricula, modern and adequate technical support, innovative approaches, implementation of ICTs in educational paths. Crucial is the leading role of teachers to present the educational content in attractive and understandable way, to involve students as active participants in the educational process, to develop their scientific and innovative thinking and ability for team working.
On the light of the above considerations, it is important to underline the fundamental role of primary school. In fact, primary school is not only the starting point of education, but its pillar: the educational objectives and the student's profile at the end of it are crucial to a proper development of competences in the following school levels and to properly set up the basics of the different disciplines. It is essential that the approach to science, even more chemistry, takes place in the early years of school, when the child is curious and observant to everything around him. Look carefully and try to design around what nature daily offers, stimulates the mind that, if properly guided, can be arranged to process scientifically each event and any information it receives. At this level, the study of chemistry will no longer be tiring, but exciting.
The choice of successful experiences and the testing of digital resources tried to be as consistent as possible with what above discussed, involving teachers and students of all school grades and stimulating the collaboration between them.

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