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CHEMISTRY IS ALL AROUND NETWORK

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Students' Motivation to learn Chemistry in Europe

Lifelong Learning Programme

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Students' motivation to learn chemistry 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 material produced (papers, reports, teaching resources etc.) is available in the project portal and the main points will be presented in the following paragraphs.

1. Introduction to the National Situation

This first section is dedicated to the organization of the school system of the eleven Countries participating in the project. Some information about the teaching of science, and chemistry in particular, are also provided.

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1.1 Belgium

The educational system in Belgium is organised by the three Communities, based on the three official languages spoken in Belgium: Dutch, French and German.

Educational institutions are regulated by one of the communities. The school system is more or less the same in all the communities. Education in Belgium is compulsory between the ages of 6 and 18. Private home education is possible, though rare.

Primary school lasts up to the age of 12 and teaches the usual subjects while secondary school can be of four types: General, Technical, Vocational and Art. This gives students the choice of pursuing specialised interests or vocations from a very young age on. In primary (6 to 12) and lower secondary school (12 to 15), science tends to be taught as a whole by a same teacher (see paragraph on training below). In upper secondary school (15 to 18), the three topics – biology, chemistry and physics – are taught as separate subjects by a specialised teacher. At this stage, pupils can choose a science orientation with more hours dedicated to science and lab sessions.

Higher education in Belgium is organized by the two main communities, the Flemish Community and the French Community. Admission to universities and colleges is fairly easy and financial aid is possible. There are a wide number of colleges and universities both regular and specialised ones teaching art, architecture, medicine and engineering.

In Belgium, there are two main educational networks: Official Education and Subsidized Private Education. Subsidised Private Education is mainly Catholic Education, organised by the General Office for Catholic Education (SeGEC) in the French Community and by the Vlaams Secretariaat van het Katholiek Onderwijs (VSKO) in the Flemish Community. The SeGEC and the VSKO work together at the national level.

1.2 Bulgaria

Schooling in Bulgaria includes training and education of students from grade one to twelve and is carried out in the following basic types of school:

According to the way of funding: state schools – municipal schools – private schools

According to the level of education:

- grade schools: grade education is carried out in two stages (primary and elementary) and respectively :
  - primary stage involves – primary schools /I-IV grade/; elementary schools /I-VIII grade/; secondary comprehensive schools /I-XII grade/; schools of arts and special purpose schools.
  - elementary stage involves – grade schools /V-VIII grade/; secondary comprehensive schools /I-XII grade/; schools of arts, vocational schools; sports schools; special schools.
- secondary schools - secondary education is carried out in
  - high schools
  - profiled high schools /VIII-XII grade
  - vocational schools
  - special school
  - schools of arts.

According to the content of training:

- comprehensive schools

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- vocational schools
- special schools

Total number of schools in the country at the beginning of 2011/2012 school year amounts to 5164 (2166 comprehensive schools and 477 vocational schools). The number of primary schools (I –IV grade) where Chemistry is not included as subject taught in education curricula is 156 only.

1.3 Czech Republic

The structure of educating system in Czech Republic begins with nursery school, than the primary school, the secondary school and the university.

The educating system of scientific subjects starts at the last level of primary school with pupils of the age of 10-11 years. The main problem is that this is very late to connect these children with scientific subjects.

At the end of lower secondary education science teaching is usually split into the separate subjects of biology, chemistry and physics [1].

As far as the university education is concerned, it is generally increasing every year. In the last ten years, the number of Czech university students (bachelor, master and doctor) has been almost doubling their number, but the growth of students in technical sciences showed a negligible change, being increased only of 17%.

In 2010, Czech universities enrolled more than 49,000 students in the fields of natural sciences, mathematics and computer science. Among them, the prevalence of men was of 64% and the share of foreigners was 12%.

1.4 Greece

Primary education in Greece begins at the age of 6, it lasts 6 years and it is compulsory for all students. Secondary education comprises the compulsory attendance of 3 years in Gymnasio (lower secondary education) and is a prerequisite for enrolling and attending general or vocational upper secondary schools. The second tier of secondary education lasts also for 3 years, constitutes the non-compulsory upper secondary education and comprises general secondary education (including Geniko Lykeio/General Lyceum) and vocational secondary education (including Epaggelmatiko Lykeio/Vocational Lykeio and Epaggelmatiki Scholi/Vocational School). In General and Vocational Lykeio, pupils enrol at the age of 15 while in Vocational School at the age of 16.

Higher education constitutes the last level of the educational system and comprises the University and Technological sectors. The University sector includes Universities, Technical Universities, and the School of Fine Arts. The Technological sector includes the Technological Education Institutions (TEIs), and the School of Pedagogical and Technological Education (ASPETE).

In Primary Education, the curricula for each subject are organized into six or fewer levels depending on the subject. Science and Geography curricula are organized into two levels (5th and 6th grade). Moreover, several science topics are included in the subject “Study of the Environment” that is organized into four levels (1st up to 4th grade). In the non-compulsory Flexible Zone (lasting 2-3 hours per week for each grade), cross-thematic teacher initiative programmes are developed. Some of these activities include Science related topics (mostly health and environmental education). The weekly

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teaching in science related areas in Primary Education involves to 4 -6 hours (including the non-compulsory Flexible Zone), which is less than 15% of the total amount of teaching hours per week.

In Secondary Education, the curricula for lower secondary school are structured in three levels with each level corresponding to each one of the three grades (7th, 8th, and 9th). The curricula include a weekly teaching in scientific topics (Physics, Chemistry, Geography and Biology) of 4-5 hours (from a total of 35 h ours). In upper secondary school (10th – 12th grades), the compulsory weekly teaching of scientific subjects (Physics, Chemistry, Biology) ranges between 2 and 6 hours. More specifically, Chemistry is taught for only 2 hours per week in only the 10th and 11th grades. Chemistry is taught for an additional 2 hours per week solely to the students who have chosen the Direction of Exact Sciences in the last two grades.

A lot of effort is also invested in the direction of laboratory teaching for scientific subjects in all Lower and Upper Secondary Education Schools. For this purpose, a number of laboratory activities are included in Science Curricula. This number ranges between 5 and 20 activities during one whole year depending on the grade. The number of laboratory activities related with Chemistry ranges between 2 and 6 per year depending on grade and direction chosen.

1.5 Ireland

The structure of the Irish education system is described below, with some indicators of the role of Science/Chemistry. Chemistry is embedded in the Primary curriculum in a stream of Social Environmental and Scientific Education, which was formally introduced in 2003/4 [2].

Primary school, which is known as National School: is for pupils aged between 4 and 11 years; Science was formally introduced in 2003-2004,

Secondary school: is in turn divided into two levels corresponding to Junior Cycle for pupils aged between 12 and 15 years (3 years long; 90% of these students study Science for Junior Certificate, which includes Chemistry, Physics and Biology, Senior Cycle is for pupils aged between 16 and 18 years (3 years long; 14.5% of the Senior Cycle students opting for Chemistry topic). Between Junior and Senior Cycle there is an optional year, Transition Year composed by pupils aged 15 years (1 year long; 50% of the related students have compulsory science topics).

3rd level University of College: for students aged 17-18 years entered in a course of study of their choice; only 13% of total enrolments is in science courses.

As far as the organization of the Lower Secondary School is concerned, science is presented as a single Junior Certificate subject with three distinct sections, one of which is Chemistry. While Ireland is unique among 21 European nations in that Science is not compulsory at lower second level, up to ninety per cent of students study this subject.

In the reform status of the Upper Secondary School, there is a relatively poor uptake of Chemistry: in 2012 approximately 14.5% of the candidature sat the Leaving Certificate examinations in Chemistry. However, there is anecdotal and statistical evidence that Chemistry students have a higher chance of gaining an A grade at Higher level, with approximately 20% receiving this grade annually. A new draft Chemistry syllabus has passed through an extensive consultation phase and is now being prepared for roll-out. The proposed new syllabus will see the introduction of a practical component in the assessment procedures.

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Chemistry teachers have been supported for some time by the Second Level Support Service (SLSS), which is now under the umbrella of The Professional Development Service for Teachers (PDST) [3]. This offers induction and continuous development training at a local and national level.

Moreover, there is a community of practitioners in Ireland who are providing excellent support to science teaching in general or chemistry teaching in particular. Young teachers are encouraged to access these facilities which are outside the realm of formal CPD but which are available for career-long support.

1.6 Italy

The general administration at national level, as far as education is concerned, is entrusted to the Ministry of Education, University and Research (MIUR) [4].

The education system in Italy is organised according to the subsidiary principle and autonomy of schools. Schools are autonomous as for didactic, organisation and research and development activities.

The education system includes the following at present:

Pre-primary education is organised at scuola dell'infanzia (nursery school); it lasts 3 years and is addressed at children from 3 to 6 years of age. The scuola dell'infanzia is part of the education and training system, yet it is not compulsory

Primary school is compulsory and lasts 5 years (from 6 to 11).

Secondary education is divided into two different levels: the lower secondary level (scuola secondaria di primo grado), which foresees a length of 3 years (from 11 to 14 years of age); and the upper secondary level of education, called 'second cycle of education', which is made up of the upper secondary school (scuola secondaria di secondo grado) falling under the responsibility of the State, and the vocational and training system falling under the responsibility of the Regions.

The State upper secondary education is offered by the liceum, the technical institutes, the vocational institutes, and the arts institutes. The overall length of study is 5 years (from 14 to 19 years of age). Vocational institutes and arts institutes offer courses lasting either 3 or 5 years. Education is compulsory for ten years (up to 16 years of age). The last two years of compulsory education (first two years of upper secondary education) can be fulfilled in all upper secondary school pathways.

Post-secondary non-tertiary education, within the higher technical education and training system (Istruzione e Formazione Tecnica Superiore – IFTS), offers higher technical education and training pathways and courses provided by Higher Technical Institutes (Istituti Tecnici Superiori – ITS);

Higher education sector consisting of university and non-university higher education. The higher education system is divided into State and non-State establishments.

Science education begins at primary school as a single, general, integrated subject area which is intended to foster children's curiosity about their environment. The teaching of science continues as an integrated programme at the lower secondary school and splits into separate subjects at the upper secondary school, in that two disciplines are foreseen, physics and natural sciences: the teaching of natural sciences includes biology, chemistry and earth sciences, grouped in an integrated programme.

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1.7 Poland

According to the new Core Curriculum (compliant with regulations of the Educational Reform in Poland) Chemistry is an obligatory school subject in Junior-Secondary Schools (3 years of study) and Senior Secondary Schools (2-3 years of study), i.e. for students aged 13-19.

Primary schools in Poland treat chemistry as one of the natural sciences and do not distinguish it as a single, separate subject. Currently chemistry is taught only in lower-secondary schools (gymnasium) and secondary schools (liceum). Primary schools have been devoid of a separate chemistry subject.

They cover chemistry-oriented issues within one subject area called Science, which includes elements of physics, biology, chemistry, geography etc. It mostly centres on environmental issues and health protection. Gymnasium level is the first one officially introducing chemistry to students in the full.

During three years long education in Gymnasium chemistry is taught within 130 hours of Chemistry - 114 hours of Chemistry education in Upper Secondary School – Basic Level (age 16-19) and 152 hours of Chemistry education in Upper Secondary School – Extended Level (age 16-19)

1.8 Portugal

The organization of the Portuguese Education System comprises: pre-primary education (ages 3 to 5), basic education (typical ages 6 to 15), secondary education (typical ages 15 to 18) and higher education. Basic education is organised according to three cycles (1st cycle (grades 1-4), 2nd cycle (grades 5-6) and 3th cycle (grades 7-9)). Presently, school is compulsory to 12th grade for any student enrolled in the 7th grade or below as of 2009/2010 [5-7].

Secondary education can be oriented to higher education access or towards working life. In the first case it offers science-humanistic courses, such as science and technologies, social and economic sciences, languages, humanities and visual arts. In the second case, technological, specialised artistic and vocational courses are offered [5-7].

Apart from the pre-primary education, where some science activities and/or projects are accomplished, science teaching started to be introduced during the basic education with the courses of Environment Study (1th cycle) and Natural Sciences (2th cycle). Chemistry dedicated courses started with Physical-Chemistry Sciences in the 3th cycle, Physics and Chemistry A (10-11th grades) and Chemistry (12th grade) in the secondary level.

Currently, chemistry integrates the study plan of the Science and Technologies area of the Sciences-humanities courses. During the 10th and 11th grades it is associated with physics in the Physics and Chemistry A course, where it covers 50% of the curricular program of this biennale course. At the end of the 11th grade, students have to attend a national exam, being Physics and Chemistry A one of the specific courses needed to access various science careers such as Medicine, Nursing, Veterinary Medicine, Pharmacy, Biochemistry, Biology, Clinical Analysis, as well as, some Engineering careers. In the 12th grade, Chemistry follows Physics and Chemistry A but with an elective character.

Chemistry teaching in the Portuguese education system presently follows a context-based approach. Nevertheless, some recent trends state the need to refocusing chemistry curricula on structuring concepts (in opposition to the in context concepts). The main curricular modifications performed during the last past years with impact on chemistry teaching, are included in three official documents from Government (Decreto-Lei Nº 286/89 (August 29th), Decreto-Lei Nº 74/2004 (March 26th), Decreto-Lei Nº 139/2012 (July 5th)). As a consequence of the aforementioned curricular modifications performed

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during the last six years period, chemistry has successively lost importance, both from students' and schools' point of view.

1.9 Slovakia

The current system of teaching chemistry in Slovak primary and secondary schools is the result of development and changes in the economy and society from 1989. Under the socialism Slovakia had a very strong chemical industry with vocational school focused on teaching chemistry and/or chemical professions. Training usually ended with graduation and has always been a combination of theoretical and practical experience. Most of these schools were at that time very well equipped, from student dormitories all the way to the chemical laboratories. There was a significant interest in specialized study at universities with a chemical focus. The best students were admitted only after intensive testing. At the moment, the situation is completely different, 80% of the chemical industry does not exist any more. There are only four schools left with chemical specialisation but also here the chemistry teaching is only to a very limited extent. Extent of teaching in elementary and secondary schools decreased at the expense of other subjects, the interest in chemistry and science declined significantly. This trend is dramatically reflected in the universities, which in contrast to the past have a big problem to admit enough students to the Faculty of Chemical Technology.

In the Slovak school system chemistry teaching begins in elementary school, which is compulsory for nine years. In the 6th and 7th grade there are 16 teaching hours per year, while in the last two years, 8th and 9th grade, there are 33 and 66 hours per year respectively. These hours include five hours of laboratory work where students are divided into groups with a maximum of 15 or 18 students. In the ninth grade there are 99 hours of theory and 23 hours of chemistry laboratory work. In some special primary schools, teaching of mathematics and science is extended to 99 hours of chemistry compulsory in both years, including 33 hours of laboratory work in the 8th grade and 23 in the 9th grade. Chemistry is also being taught on the 4 and 8 year long high schools with 99 and 66 hours, as well as on specialized secondary schools with a focus on chemistry and secondary vocational schools with an apprenticeship in chemistry. Current trends in teaching chemistry in Slovakia are the same as in other European countries. The difference is the speed and possibility of their application at individual schools.

Key trends in teaching of chemistry and its upgrading include the use of ICT technologies- computers, internet, interactive boards, integrated learning, experiments in groups etc.

The facilities of the school itself are only secondary. In this area, there are still big differences in various regions of Slovakia. Despite the fact that more than 300 teachers of chemistry participated in the project of Modernization of teaching at primary and secondary schools, the number is still not big enough and many teachers still teach the traditional way with little or no use of ICT technology.

1.10 Spain

The current educational system in Spain is based on LOE (Ley Orgánica de la Educación). In this system, students start Compulsory Secondary Education (ESO) at the age of 12, and at the age of 16 they study Bachillerato (Sixth Form), a non-compulsory education divided into three options: Arts, Science and Technology and Humanities and Social Sciences. Students do not devote a long time to study Physics and Chemistry. In ESO, they study Physics and Chemistry as parts of the same subject in 3rd of ESO (a two-hour-subject) and 4th of ESO (a three-hour-subject), but, in the latter course, it is

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not considered a mayor subject such Mathematics or Spanish Language. They can choose Physics and Chemistry or a different branch including Music, Drawing or Computing.

At the beginning of non-compulsory education, 1st of Bachillerato, the time spent in Physics and Chemistry is increased up to 4 hours a week, although it is still optional. In 2nd of Bachillerato, Physics and Chemistry are two different subjects and the majority of students must select one of the two, depending on which degree they would like to study in the future (technical sciences versus health sciences oriented Bachillerato). As a consequence, in most cases, students do not acquire enough scientific knowledge in both subjects [8].

Laboratories practices are not included in official curricula and are not obligatory. There are a few points in common with other subjects and we do not devote enough time to research and experimental work.

In Spain, ICTs have been incorporated to Science teaching in the last years.Spanish Government opted for new technologies thanks to Escuela 2.0 programme starting in 2009. This programme´s goals were to distribute more than 1.500.000 laptops among students, more than 80.000 computers among teachers, and the creation of digital classrooms equipped with smart boards, electronic boards, so as to the required software. Nowadays, due to economic reasons, the new Government has decided to implement a more economical programme based on the creation of virtual teaching environments [9]. Nevertheless, the methodological change is getting complicated due to financial education cuts, the increasing teaching hours, and the increasing number of students per classroom.

1.11 Turkey

Turkey also followed closely the studies abroad for the science instruction and put the prepared science instruction curriculum into practise in primary and secondary levels. The program development studies held by Turkey were shaped according to the results of the international researches such as PISA, TIMSS.

As for Turkey's insufficiency has been proved by international achievement evaluations, Ministry of National Education has made significant changes in the science curriculum of primary schools. The name of "science curriculum" has been replaced by "science and technology curriculum". Weekly hours of science and technology lesson have been increased to 4 from 3. In the curriculum of science and technology lesson, it is suggested that science and technology literate individuals will be more effective in reaching and using information, solving problems and producing new information. Seven dimensions have been identified for science and technology literacy (MNE, 2005): nature of science and technology, key concepts of science, scientific process skills, science-technology-society-environment relations, scientific and technical psychomotor skills, values that form the essence of science, attitudes and values concerning science.

2. Setting up of the Network

Each Country selected about ten teachers (from schools of different grade and level) and five experts in chemistry and/or education, in order to form a national network able to discuss and work on the subjects foreseen for each year of the project.

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2.1 Belgium

Since 1998 INFOREF carried out collaborative works with teachers from secondary schools and educational experts from universities or normal schools in projects related to innovative teaching technologies. Thanks to that experience, INFOREF established this partnership between motivated schools and experts in chemistry with the relevant profile: teacher trainers, university professors and ICT specialists.

Seven experts, specialised in chemistry and with experience in didactics, are involved:

- 4 train teachers in chemistry (Divna Brajkovic from HELMo, Luc Pieczynski of SeGEC, Pierre Hautier of SeGEC, Nathalie Matthys of ENCBW);
- 2 university professors (Myriam De Kesel and Bernard Tinant of the Université Catholique de Louvain);
- 1 ICT teacher (Dominique Lambert from Abbaye de Flône (Amay).

Ten schools from Brussels and the Provinces of Liège and Walloon Brabant are involved (nine upper secondary schools and one normal school) for a total of 28 science (biology, physics and chemistry) teachers and around 500 students.

The experts supervise several professor groups, divided according to: the area (Liège or Louvain), the education level of the pupils (15 or 18) and the objective of the working group:

- Group of the Province of Liège, coordinated by Divna Brajkovic: Collège du Sartay (Embourg), Collège Saint-Louis (Waremme), Collège Sainte-Véronique (Liège), Institut de la Providence (Herve)
- Group of the Province of Walloon Brabant and Brussels, coordinated by Jean-Luc Pieczynski and Myriam De Kesel: Collège Notre-Dame de Basse Wavre (Wavre), Institut de la Vallée Bailly (Braine L'Alleud), Institut des Sœurs de Notre-Dame (Brussels), Institut Saint-Jean-Baptiste (Wavre), Lycée Martin V (Ottignies-Louvain-la-Neuve)
- Group of Louvain-la-Neuve, coordinated by Nathalie Matthys: École Normale Catholique du Brabant Wallon (Louvain-la-Neuve).

2.2 Bulgaria

Based on the specific features of Bulgarian education system and science education in school, the network combines two categories of educational institutions for the exchange and comparison of experiences and knowledge in science education (Chemistry education), *i.e.* secondary schools with different profile of education and state institutions responsible for development and implementation of science education.

As far as the secondary education is concerned, five state upper secondary schools have been invited to join the network, all of them responsible for education of students 14 – 18 ages: National School in Natural Sciences and Mathematics; Vocational School in Chemical Technologies; Vocational High Schools of Electronics; Mechano-Electrotechnical High school. Ten secondary school teachers (2 from each school) in Chemistry have been involved into project activities as well as more than 200 students, age range 14 – 19, with Chemistry included as a taught subject in their Curricula.

The following institutions become part of the national project network: Sofia University, Plovdiv University, Research Laboratory of Chemistry education & Philosophy of Chemistry - Sofia; Regional Inspectorate of Education – Gabrovo. Every institution is represented by experts in Chemistry: 2

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professors and scientists, working in Research Laboratory of Chemistry education & Philosophy of Chemistry (Sofia University), 1 university professor (Plovdiv University) working in the field of Organic Chemistry and Molecular biology, 1 young researcher, working in the field of bio-analytical chemistry and as popular science communicator on radio, TV and on stage, 1 chief expert in Natural sciences and Ecology from Regional Inspectorate of Education – Gabrovo, who is responsible for the organization, implementation and control of national educational policy in Natural Sciences.

Profile of people forming the national work group by gender (11 women against 4 men), age (the largest part is the category of older than 45 years, followed by the category of 36 – 45 years old) and years of experience (the largest part having more than 15 years of experience) corresponds to a quite realistic representation of the Bulgarian situation.

2.3 Czech Republic

According to experience of ICT Prague, the network was focused mainly on teenagers attending last grades of basic schools or lower grades of upper secondary schools, i.e. at the age of 13 to 16 because this is the age when most of the teenagers form their ideas of future career.

There are involved five schools: three of them are in Prague, the nother two are from Mikulov, Moravské Budějovice. Here are the names of these schools, which are average institutions in education sector:

- Gymnázium Moravské Budějovice Tyršova 365
- Gymnázium Na Zatlance 11, Praha 5
- Gymnázium, střední odborná škola a Střední odborné učiliště Mikulov, Komenského 7
- Masaryk Secondary School of Chemistry, Křemencova 12,Prague 1
- PORG, Gymnázium a základní škola, o.p.s., Lindnerova 3, Praha 8;
- SPŠ sdělovací techniky, Panská 3, Praha 1.
- Also few experts in this area are included:
- Alexandra Hroncová is Science communicator & Marketing Specialist
- Jitka Svatošová is Project Manager
- Michaela Žaludová is Project Manager and Science Communicator
- Petr Holzhauser is Teacher Trainer
- Petr Klusoň,is University Professor.

2.4 Greece

In order to set up a functional Network, a specific strategy for the selection of teachers and scientific experts was used: The network should involve a minimum of ten teachers (in at least five different schools) with at least one of them in primary education. The secondary school teachers should have a science degree (preferably chemistry) and have taught chemistry in secondary education. Effort was also made in order to include a balanced representation of both genders. A geographical/demographic criterion was used as well, including schools from different areas of Greece both geographically as well as from a demographic point of view. In respect with the scientific experts, an effort was made to include experts of both genders and from different types of academic institutions, ie Universities, Technological Educational Institutes and Research Centres. Obviously, their scientific expertise and experience should be closely related with some chemistry discipline. Good reading skills of the English language were a prerequisite for all participants.

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The network that was finally set up had the following characteristics:

A total of 10 schools (2 primary schools and 8 secondary education schools) joined the "Chemistry is All Around Network" represented by a total of 12 teachers (3 primary school teachers and 9 secondary school teachers). All school units belonged to the public school system. Six out of the ten schools are located in the Athens Metropolitan area, three in the islands (Zakynthos, Mykonos, Aegina) and one in inland Greece (Voiotia). The 8 secondary schools involved in the network belong to upper secondary education with 7 of them being General ("Geniko Lykeio") and one of Vocational ("Epaggelmatiko Lykeio"-"EPA.L.") type.

The 10 schools comprising the main network (ie leaving out the associated schools) have an average of 240 ± 75 students (Min. 160 – Max 450). This corresponds to the typical size of a school unit (either primary or secondary) in the Greek public education system. Both genders are represented among the teachers (5 females and 7 males). All 9 secondary school teachers have different levels of experience in chemistry teaching and in all of them hold a Bachelors degree in Chemistry, except of one who is a holder of a degree in Chemical Engineering. In addition, 6 out of the 9 secondary school teachers hold a Masters degree in Chemistry Education with one of them also holding a Ph.D. degree in the same field. All three primary school teachers hold a Bachelors degree in Education, they all have experience in science teaching at primary school level and a special personal interest in science learning and teaching.

In respect with the scientific experts, a total of five experts from five different institutions joined the Network. Both genders are represented (2 females and 3 males). All experts hold a Ph.D. degree in a sub-discipline of chemistry (biological, physical, inorganic, biophysical, environmental chemistry) and have academic positions in three different types of tertiary education institutions. Namely, two of them serve as teaching/research staff at Technological Educational Institutes, two serve as teaching/research staff at Universities and one is a researcher in a National Research Centre. All Institutions are state-owned.

2.5 Ireland

The main Irish partner is the Department of Applied Science at Limerick Institute of Technology (LIT). The manager of project in LIT is Marie Walsh who has over thirty years of experience of teaching Chemistry and other life science subjects at second and third level.

The portal users are divided into three groups: Teachers, Students and Experts.

In total eight schools agreed to become involved, with a mixture of different typologies in terms of level of school, number of teachers involved, number and age of students involved. One of the schools is a National School, which is the Irish terminology for Primary school. A Gaelcholaiste is a school where the students are taught and take examinations through the medium of Irish language. All other schools participating teach through the English language medium. A Secondary school typically offers a more academic range of subjects, while a Community School offers a mixture of academic and vocational subjects.

By widening the recruitment net the project has a good mix of urban and rural schools and therefore a wider population for the next phases of the project.

List of schools, teachers and students involved:

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1. Castleconnell National School: Primary School, 2 teachers involved (Brian Dillon, Grace Kenny), 40 students involved 5-12 years aged)
2. Ard Scoil Ris Limerick: Secondary School, 2 teachers involved (Diane Condon, Rose Lawlor), 40 students involved (12-18 years aged)
3. Gaelcholáiste Luimnigh: Secondary School, 1 teacher involved (Ciara NiDhrisceal), 20 students involved (12-18 years aged)
4. Hazelwood College: Secondary School, 1 teacher involved (Michelle Herbert), 20 students involved (12-18 years aged)
5. St Attracta's Community School Sligo: Secondary School, 1 teacher involved (Ciara O'Shea), 20 students involved (12-18 years aged)
6. St Caimins Community School: Secondary School, 1 teacher involved (Shannon Maria Sheehan), 20 students involved (12-18 years aged)
7. St Joseph's Spanish Point Clare: Secondary School, 1 teacher involved (Angela Gammell), 20 students involved (12-18 years aged)
8. Tallaght Community School Dublin: Secondary School, 1 teacher involved (Mairead Glynn), 20 students involved (12-18 years aged)

The experts involved include three lecturers in Chemistry or Applied Chemistry – David Sutton, Kathleen Lough and Claire McDonnell; the Liason Officer with the National Centre for Excellence in Maths and Science – Michelle Starr; and the former Education Executive with Pharmachemical Ireland – James Ring.

2.6 Italy

The national network created for the project is composed of 10 teachers and 6 experts.

The 10 teachers have been chosen with particular care to their experience in science teaching and taking in consideration their ability to collaborate with university researchers in term of documented participation in national projects or extra-curricular activities. Among the 10 teachers, 5 are from primary school (Caterina Bignone, Giuseppina Caviglia, Barbara Mallarino, Ilaria Rebella, Rosalia Zunino) 4 are from upper secondary school (Valter Bennucci, Enza Lucifredi, Anna Pitto, Marco Rametta) and only 1 is from lower secondary school (Nadia Zamboni). The total number of schools involved was 6 (Istituto Comprensivo di Cogoleto, Istituto Comprensivo di Prà, Istituto Comprensivo di Savona, Istituto Comprensivo di Voltri, Classic Lyceum "Andrea D'Oria" of Genoa, Scientific Lyceum "Giacomo Cassini" of Genoa).

The 6 experts are various in terms of individual skills: in fact experts in chemistry education and in teacher training have been involved together with researchers in the general field of education; the latter have been involved in order to get a precious support concerning the ICT tools of education and the most suitable methods of assessment (of student motivation, of best teaching resources etc.). The group was formed by Elena Ghibaudi, researcher in bioorganic chemistry at the University of Turin, Antonella Lotti, researcher at the Department of Education (DISFOR) of the University of Genoa, Giorgio Matricardi, professor at the Department of Education (DISFOR) of the University of Genoa, Davide Parmigiani, researcher at Department of Education (DISFOR) of the University of Genoa, Alberto Regis, teacher and teacher trainer at the ITIS "Quintino Sella" of Biella, Silvana Saiello, professor and teacher trainer at the Faculty of Engineering University "Federico II" of Naples.

2.7 Poland

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Joining the project, the aim of the WSIU scientific and academic staff is to deepen their knowledge about e-learning with reference to chemistry teaching in general and in more detail. Chemistry teachers, who are cooperating with the institution, are not very technically minded and would like to broaden their horizons and gain extra qualifications in the new technologies application in the teaching and e-learning in particular.

Staff members are actively involved in the activities fulfilment and progress trying to encourage chemistry industry, teachers and experts to share their knowledge and experience about the topic. Ten chemistry teachers and seven experts were finally employed to do the activities of the project.

Primary level is represented by Joanna Błaszczykiewicz, School4Child Primary School. Mrs Błaszczykiewicz is an experienced teacher of science. Primary school School4Child was selected mainly due to the years' long cooperation in other projects and the school authorities to promote learners' autonomy in learning science. Representative of Lower Secondary School is ABiS, with the teachers Monika Pawluś and Ewa Marczewska. Moreover, Hanna Spisacka is a teacher with 16 years of teaching experience in Gimnazjum no1 in Gdańsk. Upper-Secondary Schools were represented by experienced teachers of chemistry Agnieszka Pilich, from Zespół Szkół Ogólnokształcących nr 7 in Lodz, Luiza Wężyk and Małgorzata Urbanowicz from 33 LO in Lodz, Anna Panek and Małgorzata Kozieł from 8 LO in Lodz. The latter is also a regional representative and teacher trainer of chemistry in Lodz.

Experts involvement is marked by three major higher education institutions in Lodz: University of Lodz, the Technical University of Lodz, and Medical University of Lodz. Elzbieta Zurek is a specialist in Chemistry for Pharmaceuticals at the Medical University of Lodz. Elżbieta Czarnecka specialises in Chemistry for Pharmaceutical Dynamics and is employed at the medical University of Lodz. Iwona Krawczyk-Kłys, from both the Technical University of Lodz and Institute of Leather Industry, holds the position of a researcher, and is also the Head of Department of Innovative Polymer Technology. Aleksandra Smejda-Krzewicka is another representative of Lodz University of Technology, researcher and academic teacher of chemistry and polymer technology. Edyta Grzesiak is a researcher from the Institute of Leather Industry in Lodz. WSIU's University of Third Age was also represented with its retired members Helena Kaniewska, an experienced teacher of chemistry and Jadwiga Skowrońska, expert in Biochemistry and teacher trainer.

2.8 Portugal

For the setting up of the network the following strategies have been used to involve schools and experts:

In the case of schools, the recruiting strategy was directed to the schools which already had cooperated with IPB for some years, resulting in the involvement of seven schools mainly from the region of Bragança, in order to facilitate the maintenance and quality of communication.

In case of experts, they were selected by their expertise in the areas of Chemistry Science, Science Education and/or Science Communication and by their belonging to different Higher Education Institutions.

In summary, there are 5 experts, 7 schools, 18 teachers and 470 students from Portugal, participating in the project. In the following sections, a more detailed description of the involved schools and experts, respectively, is provided.

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List of schools, teachers and students involved:

- Agrupamento de Escolas Abade de Baçal; 2 teachers involved (Arnaldo Fernandes, Adilia Tavares da Silva), 85 students involved (6-18 years aged)
- Escola Secundária de Valpaços; 2 teachers involved (Silvino Rodrigues, Lília Sofia Pires), 40 students involved (13-18 years aged)
- Agrupamento de Escolas Paulo Quintela; 2 teachers involved (Maria Teresa Palas, Abílio Ferreira Lousada), 55 students involved (7-11 years aged)
- EBS de Miranda do Douro: 2 teachers involved (Fernanda Martins, Maria de Fátima Raposo), 90 students involved (15-18 years aged)
- Escola Básica e Secundária de Macedo de Cavaleiros: 2 teachers involved (Lília Braz, João Paulo Matos), 40 students involved (12-18 years aged)
- Escola Secundária Emídio Garcia: 4 teachers involved (Luísa Maria Fernandes, Célia Bento, Teresa Pinto, Mara Emanuela Dias), 80 students involved (12-18 years aged)
- Escola Secundária Miguel Torga: 4 teachers involved (Olga Nunes, Noélia Vilas-Boas, José Alberto Alves, Ana Cristina Falcão), 80 students involved (16-18 years aged).

List of experts involved:

- Carla Morais (Faculty of Engineering University of Porto): expert in the production/evaluation of multimedia pedagogical applications for science learning. She is actively involved in Teacher Training.
- Maria de Fátima Paixão (Polytechnic Institute of Castelo Branco): expert for the Secondary Education Program of Science Technology and Society. Scientific advisor of the a MCT guide for Teacher Training;
- Maria João Seixas Melo (Faculty of Sciences and Technology/New University Lisbon): expert in the conservation of Cultural Heritage. Committed in crossing the borders of "soft" and "hard" sciences;
- Mónica S.N. Oliveira (University of Strathclyde, United Kingdom): Ph.D. in Chemical and Process Engineering. She was involved in several science dissemination activities related to fluid mechanics.
- Paulo Ribeiro Claro (University of Aveiro): interested in Public Awareness of Science activities. He has regular participation in radio science programs. Coordinator of the project "The Chemistry of Things".

2.9 Slovakia

The project Chemistry involved five schools, three of which there are high schools, one elementary school and one vocational high school. Two schools are located in Bratislava and three are from a countryside region of central Slovakia- Krupina. The sample is very representative, because it includes all levels of schools and also several country regions. The two high schools in Bratislava are known from their innovative teaching methodology, whereas the other schools from outside of Bratislava still teach traditionally.

Ten teachers participated in the project, seven of them were from high schools, two from primary schools, one teacher from a vocational school. They are usually older and more experienced teachers. A total of 200 students participated in the project, 110 students from three high schools, 50 from a primary school level and 40 students from a vocational high school.

At the expert level, the project involved five experts from the Department of Didactics in Science, Psychology and Pedagogy, Faculty of Natural Sciences, Comenius University in Bratislava. One

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expert comes from the Faculty of Chemical and Food Technology, Slovak University of Technology in Bratislava. They are specialists in didactics of chemistry, and they have been working with this issue for a long time.

2.10 Spain

5 schools from different cities of the country are involved in the project, including a total of 10 teachers and 200 students.

List of the schools involved:

- Jesus Maria Cristo de la Yedra school. GRANADA
- Regina Mundi School. GRANADA.
- San Agustin school, Motril, Granada
- Seminario Menor Agustiniano, Guadalajara.
- Santo Tomas de Villanueva, Granada

The network included also 7 experts:

- Manuel Fernández González: author of various general chemistry textbooks, which have been the manuals followed in the majority of secondary schools throughout Spain, and responsible of various teacher training courses in Spain as well as in other countries.
- Fernando Hernández Mateo is currently Full Professor in Organic Chemistry at the University of Granada
- Andrés Parra has been for the last 20 years an associate professor and researcher in the Department of Organic Chemistry of the University of Granada (Spain).
- José Antonio Martín-Lagos Martínez.started in 2005 as Researcher at the Department of Paediatrics in the School of Medicine at the University of Granada.
- Ana Martín Lasanta graduated in Chemistry in 2008 and was awared by the Spanish Educational Ministry FPU-felowship to conduct her PHD tesis in 2009. Her tesis was focus on molecular electronics and organometallic methodology.
- Ignacio Pérez-Victoria has a PhD in Organic and Pharmaceutical Chemistry; currently he is the Principal Scientist of the Chemistry Department at Foundation MEDINA.
- Antonio Parody Morreale has been professor in Physical Chemistry at the University of Granada for 25 years; as a Chemical educator he has authored three papers in the Journal of Chemical Education.

2.11 Turkey

After a thorough analysis of the project's objectives, project team decided to select target of members, schools and institutions. In detail:

- 3 high schools, 2 of them are vocational high schools
- 4 primary schools
- 16 teachers: 13 Chemistry teachers and 3 English teachers. Among them, 8 teachers are working at primary schools and 8 teachers are working at high schools
- 490 students divided in 12 classrooms
- 6 experts from three Turkish Universities (Kirikkale, Ahi Evran and Sakarya): 3 of them are Assistant Professors and 3 are Instructors. As far as the specialization domain is concerned, 5 out of 6 are experts in science education and only one in educational sciences.

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3. Main obstacles to students' motivation to learn chemistry

In the following paragraphs the national situations about students' motivation to learn chemistry are summarized, together with few suggestions to try to make the situation less worrying. All observations reported are the result of the work of selection and review of national papers and documents about students' motivation.

3.1 Belgium [10-14]

Science has lost its aura and is now associated with health risks, mass destruction and environmental degradation. Moreover, young people choose their higher education based on two main factors: first, their interest in a particular discipline and, secondly, the idea they have about career prospects in this field. Therefore they prefer more fashionable course of studies. It is observed that motivation for science is directly linked to the way it is taught and that the younger people are confronted with science the more interested they are; students like doing experiments, but not learning formulas. Most students consider that what they have learnt in science classes is useful in everyday life, but few keep themselves informed about science outside school.

It is therefore suggested to rethink science education from top to bottom. A suggested idea to get young people interested in sciences is using current issues such as global warming and explaining how science and technologies can be a solution to the problem. Students should be informed about careers in science and an emphasis must be put on science education before 14. Evidence suggests that this is best achieved through opportunities for extended investigative work and "hands-on" experimentation and not through a stress on the acquisition on canonical concepts. Teachers with appropriate up-to-date knowledge and skills are the foundation of any system of formal science education.

The best way to improve pupils' motivation is to improve teaching method:

- by enabling a large number of teachers to adopt inquiry-based and other effective teaching methods
- by supporting teachers with innovative methods and research-based knowledge
- by using the wide range of existing knowledge about how to teach science
- by sharing this knowledge between teachers, schools, national systems and researchers.

3.2 Bulgaria [15-19]

Students think that Chemistry is an unintelligible and sophisticated science and poorly motivated for learning Chemistry. Many factors are responsible for this situation (according to chemistry teachers' opinion):

- academic style of course book content which is difficult to understand for students;
- depreciated material base and insufficient modern equipment No willingness and motivation to study;
- lack of specialized literature written in easy to comprehend language;
- not enough training courses for teachers related to the interactive methods of teaching Chemistry;
- insufficient lab equipment and base;
- insufficient number of Chemistry classes and no time for lab exercises;
- large classes with no possibility to be divided into groups during lab exercises;
- too large lesson unit (students are unable to extract the most relevant information);

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- students are inadequately capable to cull textual information, read charts, diagrams, graphs and chemical equations.

The analysis of the current situation related to the problems of Chemistry school education allowed to formulate some general approaches to improve the teaching-learning process and to motivate students to study chemistry:

- improve the organization of the educational process: making explanations in easy to understand language and support them with practical exercises; involving students in scientific activities at school with their teachers, but also outside school (i.e. at universities or companies and organized by researchers and experts);
- develop tools and alternative teaching material to be used by teachers; novel innovative methods of training are to be introduced relying heavily on ICT;
- provide continuous training to chemistry teachers;
- development of conditions for self-realization of young people: young people should be offered clearly defined prospects for self realization and professional progress.

3.3 Czech Republic [20-24]

The main obstacle to students' motivation is that chemistry teaching is mostly conducted in too abstract terms so that most of the students are unable to imagine in reality what is the teacher talking about. The students try to remember the facts by heart without understanding them. The main problem is that the education in chemistry classes consists in too much theoretical lecturing instead of presentation of real life examples. The textbooks are often old and contain abstract plain text without simple explanation. Nowadays, mainly instructivistic educational approach is characterized by still prevailing dominant role of the teacher and receptive passivity of the pupils. Pupils are not able to use their knowledge in concrete situations because they cannot recognize their relation to reality. They are not able to transform their abstract facts to the real situation.

Another obstacle is the unpopularity of chemistry: more and more young people do not consider chemistry interesting and perspective but dirty or even harmful.

But the strongest obstacle is no specific support measures for low achievers in science. There is no specific support policy for low achievers in science subjects. Help for low achievers is usually provided as part of the general framework of support for students with difficulties in any subject. Few countries have launched nation-wide programmes for tackling low achievement at school. In most countries, support measures are decided at school level.

In order to increase students` motivation to study chemistry, teachers would suggest more real life examples, teaching more about issues that are useful or even essential in daily life. They should avoid instructivistic approach with students` passivity. Also usage of computers (ICT-based teaching and learning materials) can increase students` motivation: computers are well accepted by the students because they are mostly well skilled to work with it. Using computer, didactic possibilities are much wider.

Students' motivation can be also enhanced by popularization events. Activities for basic and secondary schools organized and co-organized by ICT Prague can serve as an example

One of the ways to increase interest in scientific subjects is the Foundation's Scientific Culture and Innovation Program, devoted to:

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- The promotion of scientific culture and innovation.
- Promoting network operations including projects for the dissemination of science and innovation coordinated by specific Communication and Innovation Units of the Autonomous Communities.
- The launch of new networks including projects aimed at promoting good practice in companies or other organisations which have successfully incorporated new innovations and an entrepreneurial culture.

3.4 Greece [25-29]

Greek students find difficulties in the use of chemical symbols and the application of chemistry concepts (for example atom, molecule, mass, volume and mole). The application and use of chemistry concepts and symbols depends on the students' ability to transfer from the macroscopic to the symbolic level and from the symbolic to the microscopic level and vice versa. Students' attitudes regarding the difficulty of chemistry lessons are also related to their abilities in solving chemical problems which require mathematical skills. The above obstacles are related to the nature of chemistry as a science. Other obstacles are related to the instructional content and context: the curriculum context and the abstract rigorous language employed in the textbooks, the tendency to adopt a theoretical teaching approach with very limited hands-on practical activities and without pointing the connections of the material taught with everyday life experiences and phenomena, the emphasis on rote learning, the teacher's inability to attract students' attention. Moreover, specific students' characteristics influence the decision of students not to pursue a chemistry-related career: the lack of aptitude, interest and self-efficacy. Finally, factors related to the Greek educational system and Greek society, such as the little allocated teaching time and the limited employment possibilities, have to be included in the list of obstacles to students' motivation to learn chemistry.

The most successful practices to enhance students' motivation can be divided into three main categories: a) teaching approaches, b) educational tools and c) non-formal educational material and activities.

The successful teaching approaches are related with laboratory instruction, interdisciplinary teaching approaches, and other approaches such as the use of analogies with a strong social content.

The term "educational tools" refers to information and communications technology (ICT) based applications. There have been studies which show that different types of educational software and multimedia application are connected with a rise in student interest and motivation toward chemistry.

The practice "non-formal educational material and activities" refers to museum visits, science fairs, press science and out-of school experiences that are relevant to the students' interests. The type of language employed in popularized science articles of the press seems to stimulate students' interest and motivate them towards further reading. In addition, significant correlations are identified between the topics of students' interest and their out-of-school experiences.

3.5 Ireland [30-34]

The difficulty for the teacher is in the general perception of Chemistry as a subject: it is abstract, full of concepts which are commonly a source of misconceptions for both inadequately prepared teachers and for the students. In Ireland, it has been found that only approximately 17.7% of Leaving Certificate

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Chemistry students have reached the formal operational stage of cognitive development that is necessary to cope with abstract concepts.

In recent years, several initiatives have been taken to motivate more students to study Science in general and Chemistry in particular. Industrial and governmental bodies have spoken repeatedly about the need for skill-building in the Science Technology Engineering and Mathematics (STEM) subjects, including Chemistry, that are seen as vital in underpinning the Knowledge Economy and aiding Ireland's recovery from economic downturn. As an example, Discover Science & Engineering (DSE) is Ireland's national science promotion programme, managed by Science Foundation Ireland on behalf of the Department of Jobs, Enterprise and Innovation. The objective of DSE is to bring together all existing awareness activities and expand these in a way that will eliminate duplication and provide a more focused and effective communications strategy. It aims to increase interest in STEM among students, teachers and members of the public, to contribute to Ireland's continued growth and development as a society – one that has an active and informed interest and involvement in STEM. Its activities include web resources, a careers portal, science ambassadors and active programmes like Science Week and Discover Primary Science.

Other examples of initiatives are events like local competitions and festivasl, devoted to involving students in scientific activities.

But there is no doubt that the teacher remains a primary actor in motivating students to choose to study chemistry: no less than any other subject. 'Student motivation is an essential element that is necessary for quality education. How do we know when students are motivated? They pay attention, they begin working on tasks immediately, they ask questions and volunteer answers, and they appear to be happy and eager'.

-

3.6 Italy [35-39]

Among the scientific disciplines, chemistry is the less appreciated, being considered difficult and abstract by most of the students, but also by adults, for the following reasons:

- the difficulty in the comprehension of the microscopic (abstract) level,
- the use of not adequate text books,
- the lack of experimental activities,
- the insufficient allocated teaching time,
- the low skills of teachers,

make chemistry a subject often rejected by students.

Unfortunately, promoting science is not a national priority, therefore an overall national strategy for science education cannot be claimed. Nevertheless, specific policies and local strategies have been developed to try to improve pupil and student interest in science. In particular, worth to be mentioned are projects as 'Scientific Degree Plan' or 'Teaching Experimental Sciences' characterized by joint-efforts between schools and partners from higher education or from outside the education sector, that have been put in place by the Ministry of Education (MIUR). Both of these projects point also to the collaboration between teachers and students, to improve mutual communication by developing a shared language and tools able to arouse interest.

Experimental activities are tools very appreciated and frequently used to raise students' motivation, because they make students protagonists together with their teachers and manage to show the concrete aspect of chemistry and its inextricable link with everyday life, moreover adding a pinch of

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spectacular, a pupil-friendly ingredient. The Ministry of Education, University and Research (M.I.U.R.) also encourages the utilization of innovative tools by Information and Communication Technologies (ICT) very familiar to the new generation of pupils, hence called 'digital natives' (i.e. the Digital School action plan)

But the use of practical activities and ICT teaching resources, even important and useful, is not sufficient if the objective is to improve motivation. In order to motivate pupils it is necessary to definitively abandon the traditional teaching methodology and make the student as protagonist of the teaching-learning process, in a join-effort teacher-student that will develop full comprehension of topics, but also awareness and desire to learn. Thus, a motivated student is a person who derives satisfaction in facing and overcoming the challenges he encounters during his training.

3.7 Poland [40-44]

For the purpose of the project a sample research was carried out among students of one school at the Junior-Secondary Level. 48 students were asked about their opinions about chemistry in general and the motivating factors which help them learn the subject. Their questionnaires tackled three thematic questions:

- Individual motivation to learn chemistry
- Teacher's role (if any) in motivating students to learn chemistry
- Ways of rewarding their efforts in chemistry

For what concerns the first question, a general lack of intrinsic motivation was detected, even if the 36% of interviewed students want to 'learn more' and broaden their horizons. As far as the teacher's role in motivating students is concerned, the majority of students claim that the teacher plays a crucial role in acquiring knowledge of the subject. It is mainly teacher's responsibility to interest students with the subject and to explain even complicated concepts in an easy, digestible way; his or her personality is master factor, too. and the teacher's ability. When students were asked what reward they obtain for good results at school, more than a half of them mentioned parents' approval. Self-assurance, satisfaction and the awareness of the gained knowledge are for sure true examples of intrinsic motivation and they have been identified with almost 27% of students of junior secondary schools.

Talking more in general, Polish national scene with regards to science teaching and learning required and still requires some initiatives which would facilitate learning and exploring scientific subjects. Despite local or regional problems, Polish authorities and educators are aware of the problems and are doing their best to eliminate them or at least reduce their side effect.

Polish educational system has been reformed. Teaching and learning have become more practical, developing creativity of a student's young mind and allowing teachers, at the same time to implement new technologies in their classroom.

Polish students love participating in lessons organised by Orlen or Organika companies for example. These companies are very much involved in developing students' passions and supporting teachers' initiatives in the classroom. Experiments online, lessons on demand in particular schools, visits to factories all this promotes understanding chemistry as a more friendly subject. Academic institutions such as University of Adam Mickiewicz in Poznan, University of Marie Curie Sklodowska in Lublin, University of Lodz, University of Warsaw as well as Technical Universities organise contests, lectures, 'chemistry nights', chemistry shows and experiments even for the youngest kids.

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Electronic materials, both for students and teachers, are also welcome. For students they would allow further practice and revision and for teachers they would be a useful source of extra material to be used in the classroom, during progress tests or just to consolidate students knowledge before exams.

3.8 Portugal [45-49]

Chemistry is assumed as one of the most difficult and demanding science subjects. It is recognized as involving difficult concepts, specialized terminology and mathematics. Three factors can be pointed out as the main obstacles to student's motivation to learn chemistry: (1) the negative image of chemistry in general society; (2) the type of curriculum, teaching strategies, didactic resources and lack of teacher's dynamic actions to stimulate the involvement of students into the discipline; (3) teachers' training, conceptions and convictions.

In this context it is generally accepted that motivation to study chemistry can be increased by improving the image of chemistry in society and in school. This can be achieved through non-formal activities, such as the ones involving the participation of scientific researchers, highlighting the numerous positive and appealing aspects of several chemistry applications, i.e., approaching scientists to general society. Inside school, the type of curriculum and teaching strategies are essential factors. Some studies pointed out that teaching chemistry in context seems to motivate students in their classes. This approach is currently being followed in the Portuguese Education System.

Chemical laboratorial activities can also improve positive attitudes towards chemistry and promote cognitive growth. Studies indicate that inquiry-type experiments lead to a more positive attitude towards chemistry learning. In terms of laboratory learning methods, students generally show more enthusiasm if learning through collaborative and peer tutoring work.

The importance of a learning environment where students feel comfortable to communicate their points of view and exchange ideas with their peers and teacher should also be stressed as it contributes for their development and motivation affecting the way they learn and develop/acquire competences.

3.9 Slovakia [50-54]

Interest in science subjects, including chemistry, among primary and secondary school students is relatively low in recent years. The situation is partly the result of a complete change of structure in the vocational education after 1989, partly the consequence of liberalization and destruction or re-orientation of many professional schools focusing on teaching chemistry. Low interest and students' negative evaluation of the subjects and teaching are often the result of teaching style itself. The teachers are convinced that they can give the most when they present the information, which they consider to be important, directly without respecting the students' individual interests. Students do not have enough opportunity to discuss in the classroom with other students, with the teacher, ask questions, show interest, alone or with classmates conclude their findings, examine problems and explanations. Their knowledge is often passive, partial, based on the requirements of the teacher to mechanically reproduce the learnt knowledge and skills. Students in the classroom often feel as passive recipients of the information and skills which for them have no cognitive or practical sense.

One of the most effective solutions should be a teaching focused on students, with a significant constructivist approach that stresses the active nature of cognition. Teacher should guide students

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through activities in which they develop their thinking, problem solving skills and take the structure of knowledge and skills, which will be functional enough in their further learning and practical activities. Part of the science education should also be the development of the student competences to measure, compare, sort, examine, interpret, and formalize. Therefore, it is necessary that the contents and methods of teaching science subjects reflect the interests and needs of the students, including cultural and gender specifications.

Students' interest in subject of chemistry and attitude to its usefulness can be positively influenced by the integration of its contents with the contents of other subjects, especially other science subjects, emphasising the topics and contexts, which are for students attractive and/or affect their hobby or hobbies or are a part of everyday life chemistry.

3.10 Spain [55-59]

In recent years, low students´ motivation towards science subjects has been observed, against the need for scientific literacy in society. This is reflected in the reduced number of students enrolled in science and the negative view they have about this issue.

In Spain, Physics and Chemistry (as a single subject most of the years) is not considered a basic subject like Mathematics or Spanish Language. Students can study it instead of studying other subjects like Music, Drawing or Computing. Laboratory practises are not always included in official curricula and are not compulsory. The presence of STS contents (Science, Technology and Society), like Science History, is increasing in the last years but it is still insufficient. A large proportion of teachers teach Physics and Chemistry in a very formal and quantitative way, and it is reflected in many textbooks. In this way, the institutional exams, like access to University are oriented in the same formal way. Particularly, chemistry formulation is presented like a terminological language and not as an interpretative language. These facts make students not to be aware of how important science is. While most of our students consider Physics and Chemistry boring and difficult subjects, they, at the same time, believe them to be very theoretical subjects with little chance of success due to their difficultness. They do not feel attracted to scientific work together with a clear disregard of the role of women in science.

Some of the most evident solutions ask for deep changes in Science curricula and in teaching methodology to achieve a contextual and co-operative science that also includes the use of daily chemistry, modern and technological contents, practical experiences, ICTs resources.

3.11 Turkey [60-64]

After the changes in the science curriculum of primary schools, teachers use more direct expression method, question-answer, brainstorming, concept map to support education. They are struggling to apply the program but they face some problems in practice due to lack of knowledge. They also stated that teachers have difficulties to cover all curriculum to with use of appropriate methods and techniques in crowded classroom.

The reason of insufficient program's curriculum development efforts can be that teachers who apply the program have less knowledge about implementation and also they can’t get enough feedback and benefit from them.

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In addition, are the implementation of targeted training, the preparations, the level of readiness of schools and teachers about the new programs prepared according to the constructivist learning approach enough? Do teachers understand and accept the program in desired level? Are new programs carried out in desired level? Is there any missing point or one that must be added in the content of program? Which steps in practice do teacher have difficulties? What are the problems that teachers face in practice? Teaching-learning and evaluation process should be planned according to answers of these questions or similar questions for more appropriateness with the goals of new programs.

Reasons for Lower Students' Motivation are generally stated as:

- Students' lack of previous academic knowledge:
- poor number of experiments and virtual methods;
- teachers' methodology of presentation of topics;
- textbooks with fewer practical knowledge;

In addition, it is emphasized that:

- time allocated for chemistry courses is insufficient for making experiments, activities etc.;
- physical facilities were limited for laboratory studies;
- science and chemistry in particular are difficult subjects to learn.

4. Analysis of teaching resources

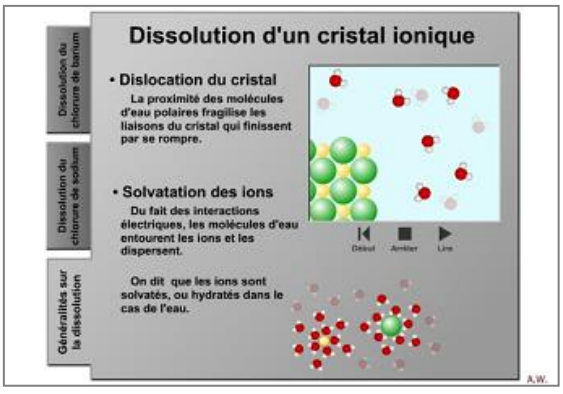
Each Partner selected about 20 ICT teaching resources to teach chemistry/science, available on internet and, when possible, in national language. The review of each resource, together with the relative link, has been uploaded on the project portal in the section "Teaching Resources"; the search engine allows to select the tools as function of: type of product, level of chemistry knowledge, pedagogical approach, subject area, target group level, language, free text. In the following paragraphs, a significant example for each Country is reported and described.

4.1 Belgium

Ionic compound dissolution (Dissolution d'un cristal ionique)

http://www.ostralo.net/3_animations/swf/dissolution.swf

This tool enables to view a modelling of the dissolution of ionic compounds in water. Short explanations describe the modelled phenomena during the dissolution.



The models represent:

1) the dissolution of ionic compounds at the microscopic level

2) two-dimensional structures of two ionic compounds (NaCl and BaCl2) at the macroscopic, microscopic and symbolic level before their dissolution in water.

3) the resulting solutions after the dissolution of the two ionic compounds (NaCl et BaCl2) in water.

It aims to:

- To model the dissolution of ionic compounds in water.

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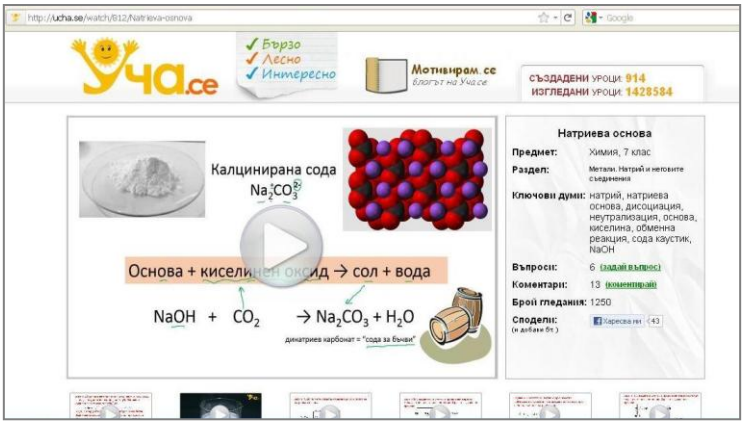
- To translate into a chemical equation the dissolution processes of salts in water.
- To use scientific knowledge to model an observed phenomenon.

When knowledge is being structured, the modelling enables to review the different levels (macro, micro, and symbolic) that will have been discovered all along the sequence. This summary enables to develop the systemic approach of the phenomenon of ionic compound dissolution in water. Indeed, the student perceives the different reading levels, which is often an impediment to learning. The most visual students will comprehend more easily the phenomena represented. However, this tool does not allow any real interactivity. It needs to be judiciously integrated within a learning sequence.

The whole website ostralo offers many animations dedicated to chemistry learning (http://www.ostralo.net/3_animations/animations_chim.htm)

4.2 Bulgaria

I'm learning (Ucha.se) www.ucha.se



The website is an educational environment with the aim of making studying a pleasant and fun activity. A leading section of the website is a collection of educational chemistry videos covering the official school program. The videos are completely free of charge and presented with intriguing narratives. The website step by step becomes an indispensable resource for preparation of students, helping them study, revise, catch up and test their knowledge in the field. The main goal of www.ucha.se is not to be just a collection of educational videos, but to be a dynamic place, where students go, study, interact with others and leave with increased motivation. Therefore, the website contains a live chat, where students discuss different topics and help one another. More specific questions are discussed also in the video sections, where the more experienced participants offer their assistance. It is not a secret that many books present the material not very attractively, which often demotivates students. The videos on the website are interesting and motivational, which explains the big interest in the website.

The main advantage of the chemistry videos is that they are narrated in a friendly and popular among students style. Every process and system are explained by visual demonstrations – pictures, schemes, figures, as the main goal is to always look for the logic behind them and avoid ineffective learning by heart. The main idea of every video is to boost the interest of the students. This is often achieved by linking the concepts to everyday life.

Another big advantage of the website is the possibility to discuss the topics presented in the videos. Questions and comments can be easily posted, which are then answered by people with more knowledge – teachers, other students, parents. The answers can be rated, which allows for sorting out the best answers from the rest. The main page of the website has also a live chat, which turns the website into a social environment, where visitors go, study, help one another, discuss different topics and make new friendships.

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The pedagogical value of the website is indisputable as it offers an innovative way of teaching, bringing the school lessons as close as possible to the students.

Proof for the high pedagogical value of the resource is the facts that for around 6 months the videos have been seen more than 150 000 times.

The website has been awarded by the jury of "BG SITE- 2012 in pixels" competition to be the best Bulgarian website in the category "Education and science" for 2012 (Fig.8). The "BG Site" competition is one of the most prestigious competitions for webs in Bulgaria and this year was its 13th edition.

4.3 Czech Republic

Experience chemistry (Zazij chemii) www.zazijchemii.cz

The sites content a laboratory section, where some questions and experiments are given. Pupils are to solve tasks and answer basic questions as well as provide results. Themes are very interesting, connected to real life and nature.

All items can be demonstrated on real life examples. For increase pupil's motivation, there is a section called Nerds. You can see here exciting experiments. This website is prepared by Oil company Unipetrol, so there is a special section about oil.

The design of web sites is nice, clear and colourful. The website provides useful materials that would take large amounts of time to be shown during classes otherwise. I think the authors want the pupils to provide results themselves. Pupils will not only get information, but they will have to work with the information and data they receive from the experiments. Pupils must work carefully and follow the rules written on the website. They can see the procedure of basic experiments. These experiments are able to be performed at home.

4.4 Greece

Chemistry at home (.....) http://www.chemistry-is.eu/

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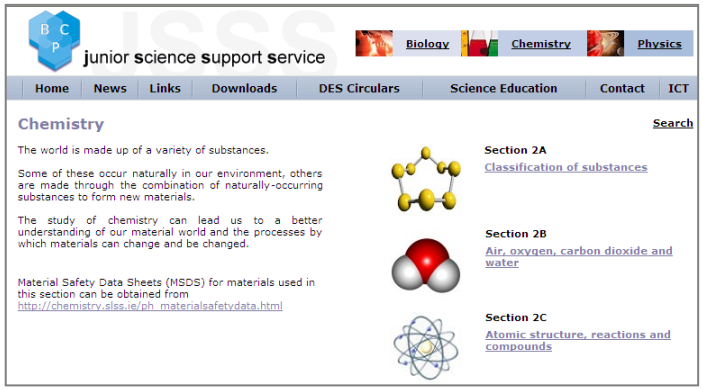
The educational package has been developed within the project "Chemistry Is All Around Us", funded by the European Commission. It aims in making chemistry more amenable to the average public by the possibility of easy-to-do experiments which bring out the presence of chemistry in numerous aspects of our everyday lives. The proposed activities and exercises aim in increasing chemical literacy and also in helping the readers develop basic scientific qualities such as logical and analytical thinking. Finally, the material aims in attracting public attention to the wonderful world of chemistry and in enhancing the motivation to learn chemistry and science in general. The teaching resource is divided in two thematic areas related with applications of chemistry at home: a) Chemical substances in Foods and b) Cleaning Products at home. Each of the two thematic areas is organized in four main sections, namely Introduction, Activities, Exercises and Relevant links. The Introduction section includes a short text with information on both the chemical concepts and the real life applications of the relevant thematic area. The text contains hot words with links to interesting related sites and also colour images. The Activities section contains two activities of increasing level of difficulty (denoted as Step 1 and Step 2). Each activity refers to an experimental procedure that can be easily reproduced at home or in a school laboratory because the materials needed, are easily found in a grocery store. The activities do not require any special chemicals or scientific instrumentation. The level of difficulty refers to the chemical concept behind the activity and not to the realization of the activity. The Exercises section is a set of two interactive multiple choice tests (one for each activity)

The resource received 8 comments from non national experts and teachers. They appreciated the educational package, stating that it is very useful to enhance students' motivation and to help teachers to introduce basic chemistry in a concrete way. Also the clarity of contents, the educational approach and the scientific reliability have been appreciated.

4.5 Ireland

Chemistry for Junior Certificate Science:
http://jsss.educast.ie/jsss.go2.ie/jsss/Main/Chemistry.htm



The aims of the Junior Science Support Service are:

to promote student-centred learning and investigation; to assist teachers to work together effectively in school; to assist non subject specialists; to help teachers to integrate ICT in science teaching and learning

This excellent website contains a wealth of support materials for teachers,

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including:

- Science Syllabus: The revised syllabus document is set out in three sections. In each section, the main topics and sub-topics are described, along with the associated learning outcomes.
- NCCA Teacher Guidelines, updated February 2006
- Curriculum Planning: Unit 9 of the planning document from the SDPI
- Electronic graph paper: This simplified excel spreadsheet allows students to input data to produce a simple line graph. The graph is drawn as the student or teacher inputs the data.
- Bulk recipes: This document contains quantities of solutions required per class for the three years - supporting the chemistry practical work.
- Mind map reader: To view the interactive mind maps on this website, it is necessary to download this viewer. It is a zipped file which will need to be extracted before it is installed.

Excellent ideas to support teachers in their efforts to provide science education at this vital stage of the students' careers. The junior certificate should be an excellent foundation for studies in chemistry or any of the other sciences. However, in the event that the student opts not to continue their studies in chemistry they should at least leave junior certificate with some appreciation of the relevance of chemistry to their lives.

Teachers can download sections for student use, to allow the students to look at the material in their own time.

This site has been commented by a Greek teacher who states it is superb, a “super tool” for the chemistry teacher of a junior high school.

4.6 Italy

Materials for special uses (Materiali per usi speciali): http://www.chemistry-is.eu/

It is an educational package developed for the project ‘Chemistry Is All around Us’. The course consists in three topics, each composed of educational text (with hot words to enable insights), interactive exercises, links and activities to be done. The topics are the following:

- “metals for special uses”
- “polymers for special uses”
- “superconductors”

Each topic has the same structure:

- educational test giving information as more as possible concrete and inherent to everyday life. The text is provided with hot words, in order to give the possibility of study more in deep the issue, but only if one wants
- interactive exercises, based on the competence acquired thanks to the information of the educational text. In agreement with the two level text, also the exercises section is divided into two levels of difficulty
- funny but educational activities to do at home as well as in class or in laboratory, with materials easy to find, safe and cheap. This section also is divided into two levels of difficulties and is useful to fix the concepts acquired by reading the text

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- finally, selected links and further information are provided for the most curious students.

The strength of the online course consists in the choice of the subjects discussed, as well as in the possibility of acquiring information by selecting the more suitable level of difficulty. Moreover, the three categories of materials are discussed in a concrete way, by focusing on practical properties and behaviour, without penalizing the scientific strictness.

The resource received 3 comments according on the innovative feature of the resource and on its utility from a methodological and didactic point of view. Moreover the comments state that the activities provided put chemistry in context. The content in each unit has a solid scientific basis and the resource offers a worthwhile educational experience for pupils.

4.7 Poland

Database of Teaching Tools (Baza Narzędzi Dydaktycznych): http://bnd.ibe.edu.pl/subject-page/9

In a nutshell it should be characterised as a collection of teaching tools available for teachers of lower-secondary schools in different subjects at lower secondary and upper secondary levels.

The portal presents results of a project to support classroom learning and individual study. The portal offers opportunities of an interesting, innovative and unconventional way of presenting Chemistry to all students. All the available material facilitates students thinking, helps faster memorization of concepts and improves understanding of various chemical processes. All tasks are supported by explanations and comments of experts and present different ways of visualization of various experiments. They can be studied by students at home as well as used in the classroom even with students of not extended chemistry profile. Tasks are provided with answers and a thorough descriptions of how to perform the experiment in safe and effective way. They are carefully graded and without any doubt motivate students to experiment on their own. The portal also gives teachers an opportunity to play with various chemical concepts visualising chemistry in a daily use. Polish teachers and experts were quite positive in comments on this resource finding it worth recommending as a useful tools for chemistry education both in the classroom and self study at home. It has been noticed that all the descriptions of the experiments are provided to allow young people to visualise them and understand chemical concepts much better. Some experiments are encouraging students imagination and help them experiment on their own. Daily use of chemistry is pointed out.

4.8 Portugal

Chemistry of things (A Química das coisas) : http://www.aquimicadascoisas.org/en/

"The Chemistry of Things" is a media project dedicated to present the chemistry hidden in our lives, showing often how scientific developments can result in the improvement of the welfare of modern society. Each TV episode, available for download at the website, is devoted to a theme. The first

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series titles are the chemistry of Tattoos, Salt, Breakfast Cereals, Alcohol, Post-its, Nail Polish, Laptops, Contact Lenses, Decaf, Detergents, Sleep and Love.

This digital resource is very well written, scientifically rigorous, with a beautiful design and attractive animations. It is not interactive.

As each episode lasts 2-3 minutes, it can be used as a thematic introduction and a factor of motivation in classroom.

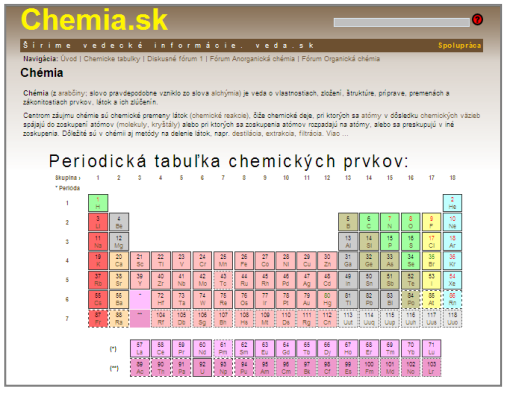
Additionally, the authors also make available smaller videos, usually animations, that can be used independently by the teacher. For example, related to the episode “The chemistry of breakfast cereals”, two smaller videos can also be downloaded: one about the Periodic Table of Elements, highlighting iron and, another, about the metallic iron oxidation in the stomach originating iron ions - a form usable by the body.

The site has Portuguese and English versions. But the videos have the option of introducing subtitles in several languages: Bulgarian, English, French, Greek, Italian, Polish, Portuguese, Slovak, Spanish, Turkish, etc.

This tool received 6 positive comments from non-national experts and teachers. One of the most frequent observations is that it is useful because it presents basic chemistry in a very concrete way: “it will assist students to realize the importance of the subject they are going to study and help to motivate them because it shows how chemistry is involved in the simplest aspects of our lives”.

4.9 Slovakia

Chemistry.sk (Chemia.sk): www.chemia.sk



Chemia.sk is a Slovak server dedicated to Slovak chemistry industry. This web page is a output of the cooperation with other web page, www.veda.sk.

This project is one of those used to develop and distribute Slovak science on the Internet through web domain www.veda.sk.

Project Chemia.sk is running because of support of these companies A-zet, Akronet, Lox Technologies, Visoft, and other people that are willing to dedicate their spare time for developing this web page. Any other help from your side is welcome whether in the form of financial or material help. Project Chemia.sk is beyond opportunities of several individuals and therefore in the case of your interest to develop this web page, you will be welcome to join.

It’s a very interesting web page for Slovak chemical industry, on this page you can find chemical tables, information about chemical education in Slovakia, specialized schools, about chemical industry

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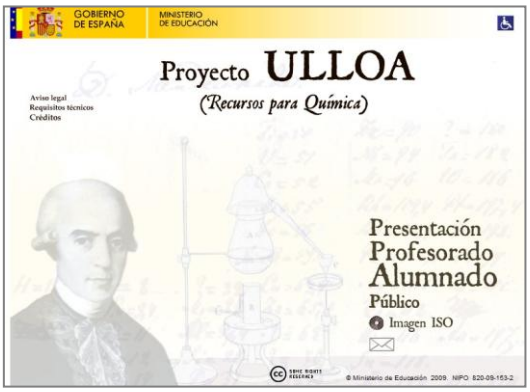
in Slovakia, about searching job in chemical industry, discussion forum and other very interesting information about chemistry in Slovakia.

4.10 Spain

Ulloa project (Proyecto Ulloa) http://recursostic.educacion.es/ciencias/ulloa/web/



The project is dedicated to Don Antonio de Ulloa, one of the greatest scientists and technicians of Spain. It aims to provide resources on the teaching of chemistry and focus attention on science education, which needs special attention in an increasingly technological society.

The material is divided in three sections: students, teachers and the general public.

The section of students is divided into compulsory secondary and high school education, including concept maps, animations, and interactive activities that serve as motivation and educational support to students. For upper grades, it allows students more control of the material and there are menus to provide access to the topic you wish to study. For high school students it includes learning objects and courses for use in the classroom. In the section for teachers we can find a description of the materials and a printable text version that can be modified by the teacher. General access does not lead to curriculum materials, but allows access to some pages, that develop basic concepts of chemistry from baseline to the second year of high school. The material provided has an high pedagogic value. It's perfectly adapted to Spanish curriculum and the teaching objects are the best example of ICT applied to teaching science.

4.11 Turkey

Education IT Network (...): http://www.eba.gov.tr/

This web-site is an educational portal directed by the Ministry of Education in Turkey. It's name is "Education IT Network". It aims at bringing students, teachers and other shareholders of education together. It stimulates to share the educational on-line materials on the portal. So, it has a huge number of educational materials. The portal also aims to support students, teachers, parents and administrators with relevant educational content for each group.

This web-site has many of the lessons of primary and secondary education as well as chemistry. It has a huge variety of educational materials like interactive activities, samples, modelling, videos, e-texts, exercises etc. Contents of this web-site are highly reliable and very well-quality in terms of scientific and pedagogical manners. There are many interactive educational materials that can attract students attention to chemistry. The interactive materials are easy to use and colourful.

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Many of the activities are aiming at making the connection of chemistry with everyday life applications and phenomena. In this way, the material aims to increase student motivation to learn and study chemistry and science in general.

The educational materials are designed for classroom use and the topics are very well grouped for the grades and lessons in the regular curriculum of Turkey. Some educational technologies like computers, overhead projectors etc. are needed to use in regular classroom environments.

There are also some blogs and forum areas on the site so that teachers and administrators can share their ideas and material.

4.12 International teaching resource: PhET

The teaching resources presented in the previous paragraphs are examples of optimal ICT resources developed at national level (or within the European project "Chemistry Is All Around Us, thus available both in national language and in English). The database of the project portal also collects numerous teaching resources developed by USA or UK and selected because really valuable for structure, contents and usability. Among them, it is worth to mention a website that is a very rich collection of simulations, provided by University of Colorado Boulder.

PhET – Interactive simulations: http://phet.colorado.edu/it/simulations/category/chemistry

The website is provided by the University of Colorado and offers many interactive simulations of various scientific disciplines and also in chemistry. In general, the activities through a graphical attractive approach, facilitate and support the understanding of concepts, viewing the phenomena even at microscopic level, with interactive models that can be manipulated by students. Notable is the availability of resources on LIM, since the whole contents of the site can be downloaded and stored on DVD.

Each simulation can be used in class as:

- activity to reinforce concepts built through a suitable learning path
- verification test at the end of a learning process: this is particularly useful for games that are inside the simulations, the game can be used as an opportunity for peer sharing solution strategies and then as a tool for stimulating feed-back of the learning process.

Good both graphics and modelling of contents' phenomena; interactive games are of good quality and easily usable; good availability of resources for LIM. Interesting is the possibility of grading the complexity of the games. There are useful educational cards associated with simulation.

The resource received 13 comments. The success of this collection of simulations can be summarized as follows:

- Availability of many simulations about different topics of chemistry, biology, physics, earth science.

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- Mainly suitable for upper secondary school level, but also for lower secondary school level.
- Simulations translated in many languages.
- Highly interactive simulations.
- Brief and simply to use simulations.

For these reasons PhET site is the most commented and attractive resource amongst those selected by our networks of teachers and experts.

5. Workshops

In September 2012, each Partner organized the "National Workshop on Students' Motivation", with the participation of the whole national network of experts and teachers.

General objectives of the workshops were:

- discussion and evaluation of the contents of the "Chemistry is All Around Network" database (Papers and Publications about students' motivation – Teaching Resources) with particular attention to the non-national materials;
- analysis of the current national situations in relation to students' motivation to learn chemistry via the personal experiences of the participants;
- collection of proposals for overcoming the problem of the lack of students' motivation to learn chemistry.

Each workshop lasted about one day and was organized in order to favour the discussion and the sharing of skills and experiences among the participants, under suitable moderation. The main results are given below, Country by Country.

In comparison with paragraph 3, where the topic of "students' motivation to learn chemistry" is discussed on the base of papers and documents, it is important to underline that the considerations about the same topic, that are given in the following lines, are the result of the national workshops and are mainly based on the personal experience of experts and teachers.

5.1 Belgium

After identifying and analysing the existing ICT resources it emerged that it is difficult to find didactic tools adapted to the students' level in the appropriate language.

In order to face this lack of suitable tools, it is proposed to teachers to create new ICT resources with the technical help of Inforef's team. For this aim, the following new tools will be developed:

- new lessons associating the use of ICT, experiments and a systemic approach;
- new sequences in chemistry: using the interactive whiteboard and modelling in addition to the experimental approach;

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- lesson sequences and 3D animations for 15 year old students. These tools are being created on the DIDAC-TIC platform http://didac-tic.sk1.be/.

Moreover, cooperation between teachers and experts has been optimised by forming working groups; experts will supervise several professor groups, divided according to the area (Liège or Louvain), the education level of the pupils (15 or 18) and the objective of the working group (analysing existing teaching resources, creating new lesson sequences using the interactive whiteboard, the systemic approach and the platform “didac-tic”).

5.2 Bulgaria

The participants in the meeting agreed on the following:

1. Motivation is an important factor in the learning process, as the teacher facilitates and underpins students’ desire to acquire new knowledge. Key factors in the motivation of students are the teacher’s qualifications, character, temperament, qualities, approach and attitude to the students.
2. The main reasons for the lack of motivation for learning chemistry can be identified as follows:
   - materials are theorized;
   - lessons are monotonous and uninteresting;
   - knowledge is not practical and useful;
   - lack of understanding of the material and hence difficulty in learning it;
   - lack of laboratory facilities and possibilities for the visualization of processes, etc.
   - limited chance to succeed on the labour market: the Business is the missing part which fails to close the cycle “school – university – career”, so one can hardly talk about students’ motivation to learn Chemistry.
3. Possible ways to increase students' motivation could be:

- students must become the focal point the process of teaching: this is the best way to motivate them;
- provoking students' interest by using more user-friendly and interesting materials, and solving practical problems associated with phenomena of everyday life;
- a more interesting and effective presentation of the material via multimedia lessons, games and exercises;
- Illustrate the material to its practical realization through industrial tours and visits to companies;
- a change in the teaching approach designed to encourage practical work on the problems of motivation, project work and networking.

4. Innovative approach for the practical implementation of these guidelines can be multimedia products (ICTs). It is necessary that an ICT based product is user-friendly, provides sufficient scientific information in accessible and attractive way to the student. It is necessary to underline that the use of interactive materials in class requires both time and proper

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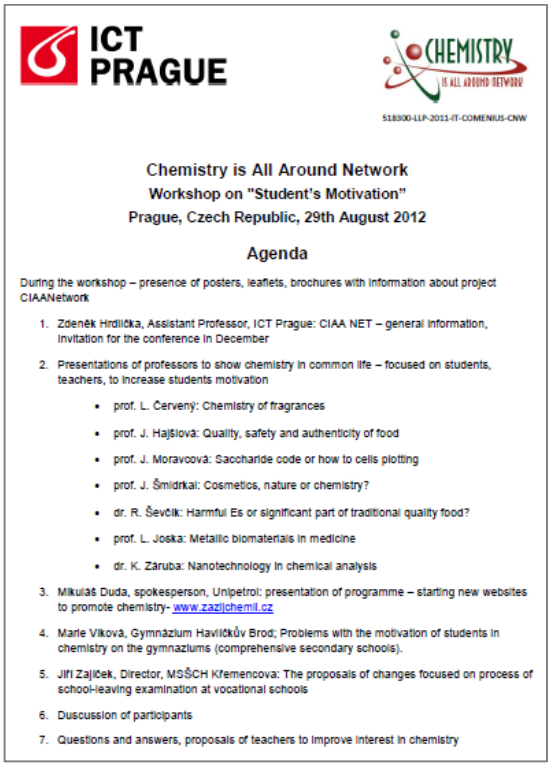
equipment; the actual state of affairs in many Bulgarian schools, however, would limit its use as a textbook in class due to lack of computers, the time constraints of lesson periods and the different level the students have in English (many good resources are in English).

5.3 Czech Republic

The Czech workshop was organized in a very original way, because it had the structure of a Conference. In particular, it was composed of seven parts. The first part was focused on different views of chemistry: very interesting topics, like chemistry of fragrances, chemistry of cosmetics, nanotechnology, were presented. The second part of workshop was devoted to Mikuláš Duda, the spokesperson of UNIPETROL Company, who presented the new websites of the project. The third part was dedicated to CIAA-Network, presented by Zdeněk Hrdlička. The part number four was about problems of motivation in studying chemistry. What are the causes? What are the results? Finally, the director of MSŠCH Křemencova presented the proposals of changes, which were focused on the process of school-leaving examinations at vocational schools. This part was followed by discussion of participants about previous topics. At the end of the workshop there was the time for questions, answers, and for the proposals of professors to improve interest in chemistry.



ICT PRAGUE

CHEMISTRY IS ALL AROUND NETWORK

518300-LLP-2011-IT-COMENIUS-CNW

Chemistry is All Around Network
Workshop on "Student's Motivation"
Prague, Czech Republic, 29th August 2012

Agenda

During the workshop – presence of posters, leaflets, brochures with information about project CIAANetwork

1. Zdeněk Hrdlička, Assistant Professor, ICT Prague: CIAA NET – general information, invitation for the conference in December
2. Presentations of professors to show chemistry in common life – focused on students, teachers, to increase students motivation
   - prof. L. Červený: Chemistry of fragrances
   - prof. J. Hajšlová: Quality, safety and authenticity of food
   - prof. J. Moravcová: Saccharide code or how to cells plotting
   - prof. J. Šmidrkal: Cosmetics, nature or chemistry?
   - dr. R. Ševčík: Harmful Es or significant part of traditional quality food?
   - prof. L. Joska: Metallic biomaterials in medicine
   - dr. K. Záruba: Nanotechnology in chemical analysis
3. Mikuláš Duda, spokesperson, Unipetrol: presentation of programme – starting new websites to promote chemistry- www.zazijchemii.cz
4. Marie Víková, Gymnázium Havlíčkův Brod; Problems with the motivation of students in chemistry on the gymnazíums (comprehensive secondary schools).
5. Jiří Zajíček, Director, MSŠCH Křemencova: The proposals of changes focused on process of school-leaving examination at vocational schools
6. Duscussion of participants
7. Questions and answers, proposals of teachers to improve interest in chemistry

During the workshop it emerged that without doubt there are significant problems surrounding student motivation towards the study of chemistry in the Czech Republic: pursuing a career in chemistry does not seem to be among the top choices for the youth but also studying chemistry at school seems to be unpopular. The main obstacle is that teaching is mostly conducted in too abstract terms so that most of the students are unable to imagine in reality what is the teacher talking about: too little real life examples in classrooms, too much theoretical technical lecturing, old textbooks with abstract plain text without simple explanation and no possibility of studying home as most of the teachers do not use any textbook and just teach “their own materials”.

5.4 Greece

The workshop was carried out by following the technique of the discussion in small groups, in such a way that it would encourage the interaction between chemistry teachers and scientific experts. Intra- and subsequently inter-group guided discussions took place in three main topics.

The workshop participants pointed out that some publications’ reviews were written in the national

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languages of the respective countries with no translation possibility in English. In addition, in some of the papers the translation in English was a Google translation which usually makes little sense.

Several of the teaching resources in the portal were found to be very interesting and useful for the teacher, and they could increase motivation.

An important conclusion that was reached is that “acting like magicians” in order to attract students’ interest has its limitations. It can be a good starting point but it is simply not enough for maintaining motivation. The participants felt that the teacher is a central figure in the process of student motivation. The teacher can exert a large influence on the students by constant encouragement, by convincing them that they can do well in chemistry. Especially in the young ages (up to 15-16 years) the teacher can largely influence motivation via his personality, personal paradigm and teaching approach. However, in several cases, teachers themselves have very low expectations from their students and they are not interested in motivating them. Also family plays an important role in the creation and development of motives to learn. The family environment can cultivate a specific learning culture and value system and help the child develop special interests. Finally, it has recently been noted that the economic crisis of the last few years in Greece has made students more responsible and more apt to develop their own motivation to learn.

All experts and teachers agreed that it is necessary for students to get informed and understand what chemistry is about. The fact that chemistry, unlike other sciences, does not have a specific catchphrase for describing its content makes it quite unfamiliar to the average person. Moreover, students’ self-efficacy and self-regulation should be built up. For this purpose, the curriculum should be designed so that it advances the general level of knowledge. It should be enriched with new interesting themes. More time is needed for active participation of the students in the educational process especially via lab work. In addition, it is useful that teachers also make use of the historical aspect of chemistry so that students get an idea of how scientific knowledge has evolved.

Teachers need to be given the possibility for constant training. They need to get informed on the latest advancements of chemistry and on the most recent findings in educational research. Finally, a systematic connection between Universities and secondary schools would facilitate both the professional development of chemistry teachers and the students’ motivation to learn chemistry.

5.5 Ireland

The participants’ discussion about teaching resources, national and non national, resulted in several conclusions:

- the quality of national materials is improving: at the end of the workshop the selection of Irish materials was highlighted so that teachers could see any that they might not previously experienced;
- participants liked resources that could use with interactive whiteboards and other supports;
- they think ICT resources are useful when students can use them for additional work at home;
- disappointment was expressed about the lack of primary school materials;
- teachers were most attracted to the visual, interactive content on websites;

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- difficulties were found in translating many non-national resources;
- some of the materials were out-of-date, with one web portal having a number of links which do not work;
- mapping to the curriculum would be beneficial as well as a reorganization by level, discipline, etc.

Concerning non national reviews on teaching resources and papers, participant noted a lack of homogeneity thus recommending that there be agreement among the partners about standardising the length, currency and detail in such papers. In addition each should be appropriately referenced. Some of the papers generated a lot of positive comment. Some of the publications were also inspiring in their reportage of well-conducted initiatives and research.

There was a lot of positive comment from the workshop participants and the majority felt the project had made a good start towards achieving its objectives. Some suggestions were made that might make the portal and the resources collected more appealing: Rank by age/level as well as by type, revamp the search engine and map to curricula wherever possible; make the portal more visually appealing and interactive, perhaps with screen-casting or podcasting from the portal itself.

5.6 Italy

The discussion between teachers and expert led to many considerations about students' motivation and the tools to improve it:

1) The problem of low student motivation in studying chemistry is a problem common to the most of European Countries. To face this situation, Governments set up a great number of programmes and projects, but concrete results are very slow to be obtained. Moreover it is not sufficient to carry out sporadic even if valuable initiatives and strategies, but it is necessary to change the way of teaching chemistry, setting a new methodology that sees both teachers and students as protagonists of the construction of chemistry concepts.

2) Despite the Italian school system is trying to keep up with Information and Communication Technologies (i.e. National Plan Digital School), considerable difficulty in selecting the 20 resources in the national language have been encountered. Availability of these tools, at least in terms of scientific disciplines, is very limited and of poor quality: resources are often unsuitable, due to the poverty of the interactive material or to the inaccurate / trivial contents.
3) The analysis of the teaching resources evidenced the difficulty of finding suitable ICT tools to enhance the teaching of chemistry, in particular when the age 5-10 is considered. The resources available for kids are often characterized by low quality or poor scientific reliability and are not adequate to the age suggested. On the contrary, a lot of material requiring deeper scientific skills can be found: a careful selection of this material can provide useful resources to be proposed to upper secondary school students.

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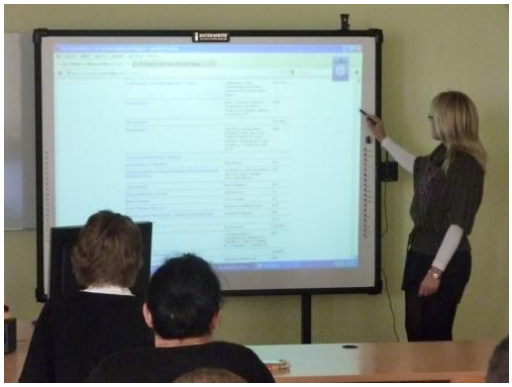
4) United States and, secondly, United Kingdom, are the major makers of multimedia resources for the teaching of science subjects. Thus, it is possible to find appropriate materials in English language for the school grade required.
5) It is possible to find several websites and portals providing interactive material dealing with various scientific topics. However they are not very useful because their contents are structured in a chaotic way. It is likely to use resources dedicated to a limited number of content that has however a simple structure and can be easily used by students, even without the help of the teacher.
6) Many interactive resources, as easily accessible and scientifically reliable, have the characteristics of playful approaches, which certainly offer a nice variation to the classic lesson, but they do not guarantee an improvement in the learning. The construction of a multimedia resource should indeed take into account the 'problem solving' aspect of the exercise proposed: a motivated student is not just a student who enjoys, but above all a person who derives satisfaction in facing and overcoming challenges encountered during his training.

5.7 Poland

The main part of the meeting was occupied by presenting the portal resources and assigning roles for further roles. Participants were also able to discuss the Polish situation with reference to teaching and learning chemistry and motivating young people to study the subject further on their own.



Teachers and experts were generally quite positive about the contents of the workshop, those who were generally positive about the project and the portal resources available online on the 'Chemistry is All around Network' platform found it useful and for those, so far quite reluctant to cooperate fully, some bits of the workshop were difficult and the portal not user-friendly. Technology mattered here a lot as some teachers complained about poor internet connection at home when they wanted to upload their comments. It was observed that some teachers really needed support in understanding contents of the portal due to the language barrier as only a few are able to speak English.

In the last part of the workshop teachers were distributed .doc files evaluating the portal and asked to complete the forms. Some teachers admitted a few bits of the portal were difficult for them mainly due to the language barrier and had a technical nature. For some who were more technologically minded some sections of the portal were very easy to follow and clearly presented. Everybody liked the graphical layout which made the content much more interesting and easy to follow.

5.8 Portugal

Portuguese teachers' opinion about workshop topics, are summarized below:

- the motivation to study chemistry in the Portuguese context decreased as a result of the last years curricular reformulations (particularly in the 12th grade, where chemistry is nowadays an elective course, with insufficient time to teach contents, particularly the experimental ones);

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- it was recognized as crucial to motivate students to have a motivated teacher;
- it was also widely accepted that motivation to study chemistry can be improved by implementing laboratorial activities and by using everyday life examples
- the use of ICT-based resources was also considered important even if they could not be seen as a teacher substitute. Long movies or other non-interactive resources should be avoided. Short non-interactive resources are only recommended to be used as an introductory motivation element or to introduce a specific subject;

- the selected resources should be student centred, motivating an autonomous and active thinking/learning process; they should be scientifically validated resources; in the case of digital simulations they should have a guide with final checkout questions, having in view the desired outcome learning objectives. Finally, when possible, simulations should be complemented by laboratory work.
- for what concerns the resources collected in the "Chemistry is all around network" portal, participant highlighted the quality, nevertheless they pointed out as preferable to have more focused and subject dedicated resources. This means that they find more useful, to have individual activities rather than portals with a high amount of information, which are time consuming to find the needed/adequate resource.

5.9 Slovakia

Participants agree that, as with other subjects, the key factor for students' motivation is the teacher figure. Chemistry is essentially a very attractive subject even though most teachers are not able to motivate students for its study. Where there are able teachers in secondary school, the number of students who go on to study chemistry is high. The motivating factor is not so much linked to a graduate's good position in the labour market of applied chemistry or related fields but more to the personality of the teacher.

Another topic of the workshop was the difference of school facilities in different Slovak regions. Schools in Bratislava, as the capital city, are doing the best, but it is not the same in other towns, especially if small.

Concerning the use of the ICT technology for teaching chemistry, teachers understood that in the present times when computers are ordinarily used by the students, teaching chemistry this way is a necessity. ICT technology is a tool that can make the teaching more attractive and better motivate students but should not be a mean standing by itself. In addition, practical activities and experiments are crucial for chemistry, therefore laboratories and school facilities are the key. ICT can help a lot and can simulate a lot of but direct practical experiments can not be replaced by anything. Participants noted there are several problems with the laboratory experiments.

Another discussed topic was the current training of the future chemistry teachers, that attend classes such as communication and social skills. These are nowadays considered essential for new

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approaches of managing group dynamics in the classroom as well as individual approach to each student. Today, these approaches allow motivating students in a more effective way as well as resolving conflicts and problems in the classroom.

5.10 Spain

The analysis of non national papers showed that:

- motivation problems on chemistry students are common to most countries in Europe;
- the lack of students motivations is due to intangible vision of students on sciences;
- science teaching is done in a very theoretical way all around Europe and it is needs to be adapted to everyday life in order to catch the attention of students to sciences subjects.

In order to arose students' motivation, participants agree in the following conclusions:

- ICT resources must be included in chemistry teaching;
- it is needed to get teacher's review on student's interest;
- it is necessary a revision of teaching science contents at students levels;
- the role of the teacher in class totally influences students choice;
- a new way of approaches from expert to scientific work is needed
- making chemistry understandable for the students is the most direct way to motivate them. In fact, many times an excess of theoretical content taught in our schools (such as formulation) makes the subject difficult and moves our students away from the science classroom.

Regarding resources, the majority of the workshop participants evaluated the amount of attractive resources that are presented in the project portal and some mentioned its great possibilities for teachers teaching in the classroom.

Finally, some meeting attendants highlighted that participating in the project and in the meeting had been very beneficial, giving them a chance to exchange ideas among different countries methods of science teaching, it is very enriching because it offers many points of view, stimulates reflection and motivates teachers to look for improvements in the "day to day" of their works.

5.11 Turkey

Workshop participants agree that students find chemistry difficult because of abstract concepts, being at molecular levels. It is important to concrete these abstract concepts for learning with understanding and for resolving misconceptions. To concrete abstract concepts makes easier everything for both students and teachers. In respect to this, in Turkey, it's seen that science curriculum and especially chemistry curriculum has many activities based on contextual learning. In contextual learning, students learn with making connections between the concepts and events that happening around. So, they can make connection to these concepts and they learn them with understanding.

Effective chemistry teaching can be made also with animations, simulations and videos: with all these alternative ways, students can concrete concepts in their minds.

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Laboratory applications are important in chemistry teaching and effective in concept learning. So there are many laboratory approaches that are used to make efficient laboratory applications and experiments. Among those kind of approaches, research-based approaches should be chosen. During the lessons, students should be motivated to make hypothesis, make guesses, make reasoning, collecting data and analyse the data and then to make some inferences about their data. That is to say, students should participate actively to the learning process. As a result of the process, students should have all these skills.

When CIAA_NET project is analysed, teachers and experts express their appreciation because it helps to:

- increase the interest in teaching chemistry;
- understand how to use chemistry to explain everyday events and life;
- provide cooperation between teachers and experts.

Moreover the project gives the chance to compare different Countries' science teaching curriculum and exchange information to each other. It is considered that this project will have very positive contributions to science teaching. In addition, it is a very useful initiative to bring together teachers from schools and experts from academia by international conferences, networks and on-line platforms.

6. Conclusions

The low students' motivation to study chemistry is a problem that affects all Countries participating in the project. It is a real contradiction for the modern society, where science and technology are continually evolving.

The main reason is in the nature of this discipline. The necessity of thinking at microscopic level generates many difficulties and the belief that chemistry is abstract and far from personal and professional needs. It is obvious that students cannot have interest in something that is seen as detached and irrelevant to their everyday life reality. Moreover, chemistry involves mathematics, being student's performance in mathematics crucial to support interest in chemistry and other science subjects.

Besides this, the mass media contribution has to be considered as too often encouraging the negative image that pupils and their families have about chemistry (pollution, poisons, ecologic disasters...).

All above is deeply wrong and needs a cooperative effort to modify this situation. Developing "an attractive catchphrase of chemistry inspiration" promoting positive aspects is important. Although they cannot solve the whole problem of the lack of motivation, promotion of non-formal activities is also an in important issue.

At political level, to improve science education is in the agenda of many European Countries. Some Countries set up overall national strategies (Ireland, Spain and Turkey), while others fund or encourage projects and initiatives at national and local level aiming to improve people opinion towards

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chemistry (i.e. popularization initiatives) or to introduce facilities into schools (i.e. computers, LIM, laboratory equipments), training courses for teachers and new disciplinary approaches for students.

Obviously, this is not enough. Thus, the question is: on what we need to focus efforts in order to improve students' motivation?

All Partners agree that chemistry/science teaching must change, since primary school. If teaching is effective, students learn significantly and are motivated to go on, willingly accepting the challenges that knowledge proposes them.

For this purpose, the teacher figure and the educational and emotional mediation that teacher makes between students and knowledge are key points, therefore it is necessary to work on them. Teacher is the pupil's reference, the person who has the task of transferring knowledge; educational mediation is the method that the teacher chooses to use in order to realize this transfer. Since the choice is suitable and the teaching effective, teacher must know the teaching-learning process and the modern educational methods, which recognize students as having an active and cooperative role in the construction of their own knowledge (constructivism, cooperative learning, peer education). Then, since there is not only one correct way to teach, sensibility and experience will help teacher to choose different methods and tools from time to time, depending on the context.

For what concerns tools suitable to enhance students' motivation, laboratory practice and ICT resources are warmly supported by all Partners, but recommending that they are only an instrument and cannot replace the teacher. Laboratory activities are important to link theory and practice, to show the connection between chemistry and everyday life, thus arousing curiosity and breaking down prejudices and the virtual laboratories are good instruments to learn how to work in the laboratory. This can be very useful, for example, to understand the safety rules before starting to work really. A virtual laboratory, however, can never teach the skill that comes from real experience

ICT is increasing in importance in people's lives and it is expected that this trend will continue, to the extent that ICT literacy will become a functional requirement for people's work, social, and personal lives. The use of ICT in appropriate contexts in education can add value in teaching and learning, by enhancing the effectiveness of learning, or by adding a dimension to learning that was not previously available. ICT may also be a significant motivational factor in students' learning, and can support students' engagement with collaborative learning.

The first year of the project has been stimulating and fruitful also thanks to the join effort between teachers from schools of different grades and experts involved in research in the field of science education. In fact, school teachers daily live the report with students, thus knowing their psychology and their difficulties to learn. On the other hand, researchers know how to carry out a well structured research in order to reach certain objectives, and are able to provide appropriate surveys. These skills, if used together, could act as valuable tools and a strong impact in science education is foreseen.

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