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Students' Motivation to Learn Chemistry in Italy

Lifelong Learning Programme

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Students' Motivation to Learn Chemistry in Italy

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Abstract

In Italy, among the scientific fields, chemistry is identified as an exemplary case study as it is recognised as one of the most difficult subjects. In order to enhance chemistry education, a key objective, is to motivate students, to raise their interest in science subjects, thus making their learning process more effective. For this purpose, the Ministry of Education, University and Research has taken a number of actions, with particular attention to the use of information technologies as educational tool for the new generations, those of 'digital natives'. The report is mainly focused on the research and selection of ICT resources for chemistry teaching and on the analysis of their efficacy to enhance students motivation.

1. Introduction to the national situation

1.1 School system structure

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

The education system in Italy is organised according to the subsidiary principle and autonomy of schools. The State has exclusive competence on general issues on education, on minimum standards to be guaranteed throughout the country and on the fundamental principles that Regions should comply with within their competences. Regions share their competences with the State on education issues while they have exclusive competence on vocational education and training. 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. These nursery schools are co-educational establishments and may be located on the same premises as primary schools or on separate premises. They are the only type of pre-school in both the State and non-State sectors. The scuola dell'infanzia is fully included in the educational system.

The first cycle of education, which lasts a total of 8 years, consists of primary school and the first cycle of secondary school. Primary school and lower secondary school are two different education levels, each with its own specificities, even though they are part of only one school cycle.

Primary school is compulsory and lasts 5 years (from 6 to 11). It consists of a first year that serves as a transition from nursery school and two successive periods of two years. Primary education is provided at legally recognised State and non-State schools.

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 lower secondary school, 'is aimed at fostering the ability to study autonomously and at strengthening the pupils' attitudes towards social interaction; it is characterised by the different teaching and methodology approaches according to the development of the pupils' personalities; it progressively develops choice skills and abilities according to the pupils' aptitudes and inclinations; it

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helps to orientate oneself in the future choice within education and training' (Legislative Decree no. 59/2004). It is divided into a first two-year period and a third year for guidance and the transition to the second cycle of education. It is provided at public schools and at legally recognised private schools.
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) both in the liceum and in the technical institutes, except for the liceum specialising in arts subjects which offers a course of study of 4 years plus an additional year. Vocational institutes and arts institutes offer courses lasting either 3 or 5 years.
Education offered by the licei aims at preparing students for university studies and for other post-secondary pathways, whereas education offered by the liceum specialising in arts subjects aims at teaching art.
The classical and scientific liceum have a unified structure (lasting five years) which are split into two and three year sections. In the classical Liceo, the teaching is predominantly classical and humanistic. The scientific liceum places the emphasis on scientific training, particularly during the last three years.
The main purpose of technical education is to give pupils specific theoretical and practical preparation for skilled tasks (vocational education) and preparation for work and artistic production (artistic education) in various sectors, with particular attention to the requirements of the local labour market.
This type of training is given in technical, vocational colleges and in art institutes.
There are different types of Istituti tecnici (technical colleges): agricultural, commercial, touristic, surveying, industrial, company experts and correspondents in foreign languages, naval, aeronautic and social activities. Each offers several branches and specialisations. The courses are divided into two cycles (one of two years and one of three years). However, there are no examinations between these two cycles and the programmes are the same in the two-year period and differ in the three year period with regard to specialisations.
Istituti professionali (vocational colleges) cover three-year sectors and the following vocational studies: agriculture, industry and crafts, services, auxiliary sanitary and the special sector. Each sector offers a number of branches which correspond to the most important areas of professional life. These colleges may also organise evening courses.
The istituti d'arte (arts institutes) prepare pupils for work and artistic production, according to local industries and materials. There are about 40 regulated directions and these take into account many sectors: printing and engraving, textiles and decorations, jewellery, metals, furniture, ceramics, painting, glass, set design, etc
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.

1.2 Science education at school

Science education begins at primary school as a single, general, integrated subject area which is intended to foster children's curiosity about their environment providing them with basic knowledge about the world and giving them the tools with which they can investigate further. Integrated science subjects promote a questioning and investigative approach to the environment and prepare children for more detailed studies in later grades. Teaching is usually organised in broad themes, such as states of matter, vegetable world, human body etc.
The teaching of science continues as an integrated programme at the lower secondary school and splits into separate subjects at the upper secondary school, but not completely. In fact, after the recent

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reform of the school system (introduced with Law no. 53/2003 and the subsequent decrees), the teaching of science at the liceum foresees two disciplines, physics and natural sciences: the teaching of natural sciences includes biology, chemistry and earth sciences, grouped in an integrated programme.
As an example [1], the table 1 reports the minimum compulsory annual timetable for natural science, in comparison with physics and mathematics, at different kinds of liceum.
(1) It replaces natural sciences in the 3rd and 4th grades in the following branches: architecture and environment, figurative arts, design, set designing.
Different and less homogeneous is the situation at technical institutes and vocational schools where chemistry and other scientific disciplines are taught separately: annual timetable and specific name of the courses are function of the kind of school and of its specialization.

2. Setting up of the network

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, 4 are from upper secondary school and only 1 is from lower secondary school. The participation of many primary school teachers has been particularly researched because the first approach to science is realized at this school level, thus giving the “forma mentis” that the pupil will bring with him throughout his school carrier and even after; pre-primary school does not foresee any activity as regard to science.

	subject	1st grade	2nd grade	3rd grade	4th grade	5th grade
artistic liceum	mathematics	99	99	66	66	66
	physics			66	66	66
	natural sciences	66	66	66	66	
	chemistry of materials[1]			66	66	
classic liceum	mathematics	99	99	66	66	66
	physics			66	66	66
	natural sciences	66	66	66	66	66
scientific liceum	mathematics	165	165	132	132	132
	physics	66	66	66	66	66
	natural sciences	66	66	99	99	99
linguistic liceum	mathematics	99	99	66	66	66
	physics			66	66	66
	natural sciences	66	66	66	66	66

The group of experts is 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.)
In detail the network is composed by the following teachers and experts:

Teacher 1. Bennucci Valter
Teacher of science at the ‘Andrea D’Oria’ Institute of Genoa. He has 12 years of experience in teaching.
Andrea D’Oria is a classic lyceum with about 800 students enrolled, between 14 and 19 years old.
Teacher 2. Bignone Caterina
Primary school teacher at the ‘Istituto Comprensivo Prà’ of Genoa. She has 13 years of experience in teaching.
Istituto Comprensivo Prà gathers 1 pre-primary school, 3 primary schools and 2 lower secondary schools with about 900 students enrolled, between 3 and 13 years old.
Teacher 3. Caviglia Giuseppina

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Primary school teacher at the 'Istituto Comprensivo Prà' of Genoa. She has 35 years of experience in teaching.

Teacher 4. Lucifredi Enza

Teacher of science at the 'Andrea D'Oria' Institute of Genoa. She has 36 years of experience in teaching.

Teacher 5. Mallarino Barbara

Primary school teacher at the 'Istituto Comprensivo Savona IV' of Savona. She has 12 years of experience in teaching.

Istituto Comprensivo Savona IV gathers 4 pre-primary schools, 3 primary schools and 2 lower secondary schools. About 1000 students are enrolled, between 3 and 13 years old.

Teacher 6. Pitto Anna

Teacher of science at the 'Giacomo Cassini' Institute of Genoa. She has 28 years of experience in teaching.

Giacomo Cassini is a scientific lyceum with about 1500 students enrolled, between 14 and 19 years old.

Teacher 7. Rametta Marco

Teacher of science at the 'Giacomo Cassini' Institute of Genoa. He has 23 years of experience in teaching.

Teacher 8. Rebella Ilaria

Primary school teacher at the 'Istituto Comprensivo Savona IV' of Savona. She has 14 years of experience in teaching.

Teacher 9. Zamboni Nadia

Lower secondary school teacher at the 'Istituto Comprensivo Cogoleto' of Cogoleto (Genoa). She has 20 years of experience in teaching.

Istituto Comprensivo Cogoleto gathers 1 pre-primary school, 1 primary school and 1 lower secondary school with about 700 students enrolled, between 3 and 13 years old.

Teacher 10. Zunino Rosalia

Primary school teacher at the 'Istituto Comprensivo Voltri I' of Genoa. She has 29 years of experience in teaching.

Istituto Comprensivo Voltri I gathers 4 pre-primary schools, 4 primary schools and 2 lower secondary schools. About 1000 students are enrolled, between 3 and 13 years old.

Expert 1. Elena Ghibaudi: researcher

Her research activity, at the university of Turin (Italy) falls within the field of bioinorganic chemistry.

She is also interested in the problems related with science education and teaching and collaborated (both as a lecturer and as an organiser) to: SISS (Advanced school for training second level teachers), SPAIS (training course for science teachers of the secondary school, yearly held in Sicily) and the "Scuola Segre" (Summer school in educational research and didactic of chemistry, yearly organized by the Italian Chemical Society)

Finally, she has some experience in science communication, as she collaborated with TUTTOSCIENZE, the scientific page of the italian newspaper "La Stampa" and she is part of the editorial staff of the monthly journal "L'alambicco – distillato di notizie su chimica e società", that is published by the University of Turin and aims at promoting the knowledge of chemistry amongst the general public.

Expert 2. Antonella Lotti: researcher

Researcher at the Department of Education (DISFOR) of the University of Genoa.

She got a PhD in Medica Education (Italy 1992).

She is a member of Directory Board of Italian Society of Medical Education (since 2005). She led a teacher training biennial program about nutrition education in years 1990-1992 (funded by Italian League against Cancer). She guided and supervised a project dealing with the introduction of science education in a network of 5 schools (from primary to high school) funded by Compagnia di San Paolo (Torino) in 2011-2012.

She is the coordinator of the Center of Medical Education, University of Genova, since its creation in 2010.

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She is an expert of active and interactive education methodologies like problem-based learning and project-based learning.
Her research activities are in the field of teacher training, tutor training, faculty development in educational institution for health.

Expert 3. Giorgio Matricardi: university professor

Professor at the Department of Education (DISFOR) of the University of Genoa.
Between 1977 and 1990, his main research interest was the ecology of the benthic communities of the infralitoral zone of the Mediterranean Sea.
In 1990, the cultural background built up in the context of the marine ecological research allowed him to focus the interest on science education. Under the urgent request of collaboration from both the world of education and the not specialized public, he collaborated with curricular (schools) and non curricular subjects and Institutions to develop several research projects, which conjugated the ecological knowledge with the constructivistic paradigm of education. He collaborated with national and international (EU, UNESCO) research programs on educational topics; he is member of national and international scientific societies and participates to the editorial board of the international journal "Culture della sostenibilità" (ISSN 1972-5817).

Expert 4. Davide Parmigiani: researcher

Researcher at the Department of Education (DISFOR) of the University of Genoa.
His main research fields are focused on:

- the use of ICT in the classroom for an effective learning environment
- the design and evaluation of learning environment (teaching methods, assessment strategies, etc.)

He's teaching as compulsory subjects "EDUCATIONAL TECHNOLOGY" and "CURRICULUM DEVELOPMENT AND LEARNING ASSESSMENT" within the master degree named "SCIENZE DELLA FORMAZIONE PRIMARIA", the course for the future primary school teachers.
He was also lecturer of "CURRICULUM DEVELOPMENT" within the master degree for future secondary school teachers (SSIS).

Expert 5. Alberto Regis: teacher and teacher trainer

Chemistry teacher at the ITIS Q.Sella of Biella (from 1978 to 2008). Professor of Didactic of Chemistry within the master degree for future secondary school teachers (SSIS) at the University of Turin (from 2000 to 2008). Teacher trainer in Science Education since 1991. Author and co-author of approximatively 20 papers about the didactic of scientific disciplines. Co-author of the following books: Stechiometria, Calcoli e Concetti (ed.Paravia, 1991), Chimica delle Fermentazioni e Laboratorio (ed. Paravia, 1995). Current vice-president of the Teaching Division of the Italian Chemical Society (DD-SCI)

Expert 6. Silvana Saiello: university professor and teacher trainer

From1985 – to today Associate Professor of Chemistry, Faculty of Engineering University Federico II Naples (Italy).
From 2005 to 2008 Project leader: "The spread of the model CRUI for quality assurance of degree programs" in University of Naples Federico II (Italy).
From 2000 to 2005 Coordinator of Graduate school for Sciences teaching (Campania Region, Italy).
From 2000 to 2005 Project leader: Learning by experiments" in University of Naples Federico II (Italy).
From 1998 to 2002 Coordinator of Education Committee of the Faculty of Engineering University of Naples Federico II (Italy).
From 2005 to 2010 Teacher Trainer in the project of Italian Ministry of Education: Teaching Experimental Sciences.

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4. Main obstacles to students' motivation to learn chemistry

4.1 National policy

In Italy, 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).
Different reasons can be mentioned as the driving force for developing the above actions to improve science education, but the most meaningful are:

- declining interest in science studies and related professions;
- demand for qualified researchers and technicians;
- unsatisfactory results in national and international surveys (i.e. INVALSI surveys [2], PISA 2006 [3]);
- bad image of science in citizen's mind.

The latter have been evidenced by national and international surveys, researches and documents published by experts in the field of education, national reports, discussions with teachers and former students; an exhaustive database of related documents has been produced and uploaded on the portal of the project 'Chemistry Is All Around Us' [4] funded by the European Commission (March 2010-February 2011).
Among the scientific disciplines, chemistry is the less appreciated, being considered difficult and abstract by most of the students, but also by adults. For this reason, the Italian Chemical Society, the most important association of chemists at national level, has always been focused in the effort of improve the image of chemistry and its teaching, collaborating with schools and government institutions.

4.2 Students' motivation

A key objective to enhance science education, is to motivate students, to raise their interest in science subjects, thus making their learning process more effective. That is particularly difficult when the discipline considered is chemistry. In fact:

- 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.
Two main national projects are currently devoted to enhance student's scientific literacy as well as teachers skills, involving.
The national project 'Teaching Experimental Sciences' (ISS) [5] is addressed to primary and the first two years of lower secondary school. One of the objectives of the plan is to support the training of teachers, organized in communities of practice and supported by local presidia; teachers, after proper training, can develop and promote experiences and formal and informal training in science, towards colleagues. The ultimate goal of the initiative is to raise the scientific literacy level of Italian students.
The national project 'Scientific Degree Plan' (PLS) [6] started in 2005 as an answer to the dramatic drop of matriculation to scientific degree courses (Chemistry, Mathematics, Physics, Material Science), registered in our Country. It has been realized all over Italy and it consists of initiatives oriented to arouse interest for science in students from secondary schools. It is directed at both

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teachers and students and aims to build a bridge between school and university. It consists of many different initiatives, like seminars, laboratories, etc. to be held at school, as well as at university. The main goal of the project is to promote the study of scientific disciplines. Tools to reach the goals described are: to increase the diffusion of scientific culture in the secondary school and to start a process of refresher courses for teachers. The main idea driving the project is the need to the direct involvement of students in laboratory activities as a tool to increase their scientific knowledge.
Both of these projects point to the collaboration between teachers and higher education representatives, but, above all, between teachers and students, to improve mutual communication by developing a shared language and tools able to arouse interest.
Experimental activities are teaching resources very appreciated and considered efficacious to gain students involvement in chemistry lessons. That is of course true, because experimental activities 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 spectacular, a pupil-friendly ingredient. But they are not sufficient if the objective is to improve motivation.
At this point it is useful to clarify the meaning of the word 'motivation', that is far from obvious and the latter cannot be used as synonymous of enthusiasm or, even worse, enjoyment.
Enthusiasm and enjoyment are certainly immediate and evident moods that seem to make chemistry more friendly and even easier but their effect do not lasts long because they are based on surprise and charm of novelty.
Motivation is more difficult to be obtained and is the result of a long and hard work, but is long-lasting and self-sustaining. In order to motivate pupils it is necessary to make them 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.
For this purpose, language used to communicate scientific contents is fundamental. Pupils, especially if kids, encounter difficulty in the study of chemistry because they do not know the scientific language, they cannot understand the texts in which it is presented without suitable mediation and they find difficult to think at a microscopic level. In order to make them capable of read and understand scientific texts, it is necessary to start from their own language and concepts, then build gradually a more complex language together with the knowledge of phenomena, through the implementation of experiences and the reflection on them. Then they will be able to extend their understanding from the macroscopic to the microscopic level.
Innovative tools, increasingly introduced in teaching methodologies, are provided by Information and Communication Technologies (ICT). The Ministry of Education, University and Research (M.I.U.R.) encourages the utilization of these technologies, also because they are very familiar to the new generation of pupils, hence called 'digital natives'.

4.3. ICT for school education

Widespread use of new technology in schools was introduced by means of the School System Reform in 2003 concerning the 1st cycle of education (primary and lower secondary school). A wide offer of initiatives has had the aim of renewing and enhancing the teaching/learning methodology to better cope with the needs of teachers, students and families. The major initiatives have concerned:

- Supplying schools with multimedia equipment
- Connecting schools to the Internet
- Setting up networks and services
- Training teachers

The Digital School action plan [7] is the main, but not the only one, project adopted by M.I.U.R. to promote the use of ICT in the teaching/learning process. The initiative is developed in two phases: the introduction of Interactive Whiteboards (IWB) in the schools and the development of digital classes [8] – cl@ssi 2.0. (156 classes at lower secondary level monitored in order to evaluate the impact of ICT and the new learning environment on students' performance and skills) [9,10].

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INDIRE (National Institute of Documentation, Innovation and Research on Education) has developed a database system which collects resources to be used by teachers. The most meaningful is Gold [11], the database of best practices, including the Learning Objects produced by teachers.

5. Analysis of the teaching resources

5.1 Selection of ICT teaching resources

Unfortunately, the availability of national ICT teaching resources for science, chemistry in particular, is far to be rich. More fruitful is the research of resources for mathematics and much more for humanistic disciplines.
The ICT education sector in chemistry/science is still at an embryonic stage in our Country: valuable resources are being developed, also thanks to projects funded by M.I.U.R., but they are not yet sufficiently shared, thus difficult to be found.
The main risk, surfing in Internet without appropriate references, is find free but low quality resources, due to the poverty of interactive material or even to the inaccurate/trivial contents.
Many of the interactive resources selected and available on the CIAA_NET portal, as easily usable and scientifically reliable, have the characteristics of ludic approaches, which certainly offer an attractive variant to the classic lesson, but this does not ensure an improvement of learning. The construction of a multimedia resource should, in fact, take into account also the problem-solving aspect of the tutorial, according with what has been said about students' motivation.
The choice of the most worthy teaching resources has been done by all the members of the national network, in cooperation. At first, many digital resources to teach science/chemistry were gathered as result of the internet seeking of each one, than a meeting was carried out in order to discuss strength and weakness points of those resources. In order to select the 20 best digital tools, the choice has been made taking in consideration the following features, sorted by relevance:

- resources in Italian language
- easy to use
- useful to practice independently
- motivating (that facilitate understanding)
- requiring the active participation of the student
- problem-solving
- technologically advanced (i.e. APP)

On the base of the above priorities the first list of selected material has been reduced and the resources characterized by low interactive contents have been deleted as well as many resources in English. Only the most valuable, interactive and easy to use resources have been reviewed and are presented below: 12 are in national language, 1 in French, 5 in English and 2 are in English but also translated in Italian. Most of them are suitable for upper secondary school, very few can be used with younger pupils.

1) ArgusLab 4.01
http://www.arguslab.com/arguslab.com/ArgusLab.html
It is a software that helps students to become familiar with organic molecules, even complicated such as molecules belonging to biochemistry. The program allows to draw very complex molecular configurations, for instance proteins, obtain helical chains of amino acids and folded leaves etc. ArgusLab uses a tree system to organise all the elements to add to any structure before representing this data as a drawing, allowing you to analyse it in a visual manner. In particular the use of the software leads to: draw and modify molecular structures in 3D, know all the chemical features about Carbon and its covalent bond, know all the chemical features about reactive groups, measure the bond distances, the bond angles, the torsion level of carbon chain. It is an amusing tool to learn chemistry, easy to use, suitable for PC and Tablet.

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This resource received 3 comments. In particular it has been said that the software program would be suitable for use with an advanced/special interest group of students who may choose to download it and explore its possibilities in their own time. It is a good introduction to molecular modelling due to the fact that it is so widely available and easy to get started with. This program may well enhance the interest of students who are already interested in chemistry and willing to put in the effort to get to grips with the program. It may be of use to teachers to prepare images of molecules which can then be incorporated into presentations to class or manipulated by students themselves, depending on the IT resources available in the classroom/lab.

2) BBC School Science 2012

http://www.bbc.co.uk/schools/ks3bitesize/science/

It is an interactive site aiming to teach, both at a microscopic and at a macroscopic level, the states of matter, the properties and behaviours of materials, the matter composition, the nutrients and their effects on human body.

The site consists of four subject areas:

- Organisms, behaviour and health (Life processes, cells, health, variation and classification, feeding relationships)
- Chemical and material behaviour (Solids, liquids and gases, periodic table, pH scale for acids, bases and alkalis)
- Energy, electricity and forces (Energy, forces, electric currents and magnetism)
- The environment, the Earth and the universe (Rock types, astronomy, and the environment)

Each area consists of some sub-areas that can be viewed clicking on the area title. Each sub-area provides three kinds of tasks: revise, activity and test.

It's a friendly website with a lot of animations, clear images that explain the different contents and the possibility to use subtitles if you need. In the “Third degree” (at the end of the Activity) you have an immediate feedback. You can print all the schedules and tests with the right and the wrong answers and their explanation. The variety and the care of contents is appreciable.

The resource is a little difficult for primary school level, but useful for lower secondary school.

The site received 3 comments: the resource material could be used directly in the classroom or as a follow-on activity once the various topics have been taught in class. Students should find it very easy to work through the resource at their own pace as each topic is laid out in clear, easy-to-follow sections, and after working through the text, they can advance to an interactive type video activity.

3) Biochemistry unit

http://www.ngfl-cymru.org.uk/eng/index-new.htm

The resource is an interactive site that deals with biochemistry, in particular food molecules, such as carbohydrates, fat and protein; there are also references to digestive processes and to the most important carbohydrates (glucose, starch, glycogen, cellulose) The activities proposed in this site develop the knowledge gradually, from basic to high level. This resource could be used consolidating knowledge about food molecules and their chemical structure, for 13-14 aged students; it’s possible to use it on a whiteboard, for a single student but also for a group activities.

There are attractive graphics and simple and effective simulations. The download allows you to use separately the different section, according to the teacher’s planning.

The resource received 2 comments, stating that it seems to apply methodological assumptions for teaching and is very useful for teachers and individuals who want to work at home.

4) Che cos'è la Chimica? What is Chemistry?

http://www.whatischemistry.unina.it/it/home.html

‘What’s Chemistry’ is a site (more precisely, an hypertext) aiming to build and/or expand the knowledge of single persons but also of groups of students working in class. It discusses the different aspects of chemistry as science as well as discipline. The hyperlinks start from basic concepts and

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then move to high level concepts in a natural and gradual progression. The homepage provides 5 possible starting points for paths of knowledge: 1.Chemistry is an experimental science, 2.Industry, 3. Life, 4. Environment, 5.Art.
The objective of the resource is to spread the knowledge of chemistry by evidencing several areas in which chemistry plays a very important role. Information are provided with scientific rigor without being heavy or difficult.
The resource received 2 comments because its main purpose is to attract the students' interest and show how important is the role of chemistry in areas such as science, environment, art, industry and life. Using several examples, there is an attempt of absolving the term "chemical" of something negative, which is falsely used by the media as something that implies hazard and aggressiveness. The students can easily use the website and receive all the necessary given information by using either the five possible starting points or the numerous questions and answers included in the website. Overall the site can have a positive effect in increasing student motivation to learn chemistry.

5) Chemsketch 12 software 2010
http://www.acdlabs.com/download/
Chemsketch 12 is a chemical structure drawing program developed by ACD/Labs. Among other features, ChemSketch has the ability to:
- draw molecules in 2D
- render a 3D view of the drawn structure
- generate IUPAC systematic names for molecules of up to 50 atoms and 3 ring structures
- predict NMR spectra of the drawn molecules

It is probably the most simple and fast software to create three-dimensional models and to draw 2D molecules. The software is easy to use, rich of options and suitable to correctly draw even complex molecules, in 2D as in 3D. The confidence with this software can be a valid tool in the teaching-learning of molecule structures and their nomenclature, in particular when organic molecules are considered. In this case, a good use of the software is an indispensable complement to books.
The resource received 1 comment agreeing about the usefulness and usability of the software.

6) Chimica Pratica
http://chimicapratica.altervista.org/home.html
It is an interactive site, mainly proper for upper secondary school. It provides:

- laboratory cards related to instruments description, experiments, pieces of information to prevent industrial accidents
- deepening cards on some theoretical aspects
- interactive simulations of chemical and physic phenomena from the Phet, Project of the University of Colorado
- software that can be downloaded free of charge and referring to molecular graphics, calculation of the molecular mass, numerical exercises on: acid-base pHs, hydrolysis reactions, mixtures, titrating reactions, buffers, solubility, conversion of multi-media file formats (audios, images, videos, DVDs, CDs, ISOs)
- Games

It is a nice site aiming to give teachers and students a pleasant didactic tool, useful to visualize the concepts to be acquired, by making their comprehension easier.

7) Chimicamente
http://digilander.libero.it/chimicamente
The resource is a software targeted for students of the upper secondary school; it is required that the student knows the basic knowledge of chemistry. It is designed to present some simple exercises about molecular weight, electronegativity and periodic table.

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The software allows students to face some exercises directed towards the calculation of mass, volume, molarity and concentration. Students can choose 8 different exercises. It allows three levels of approach: a presentation by the teacher to show how to do some calculations with the chemistry elements; an individual work where the student can calculate the various molecular masses; a group work where the teacher can present simple problems to the students who have to discuss how to solve it. The resource doesn't allow complex handling. The students can choose limited changes, so it is useful to present chemistry's basic aspects.

8) Construire une séquence sur les gaz utilisant un logiciel de simulation - Atelier Théorie Cinétique des Gaz

http://www.epi.asso.fr/revue/articles/a0306d/Gaz_a.htm#a

It is a software dealing with the theme of the thermo elastic properties of gases; it could be addressed to high school, but also used at the University. The attached documents provide the guidance and resources necessary to ensure teachers build their own sequence of instructions, so as to be appropriate to the level of conceptualization of their students. The representation of the gas is particle: the particles are in constant chaotic movement. The following parameters can be varied: the type of gas, the speed of the particles (in relation to the temperature assigned to the system), the number of bumps on the parts of the container (in relation to the pressure of the system), the number of gas particles. Morover you can choose to have two containers separated by a wall which may be mobile or bound or even perforated. After each change, both the macroscopic system's and the particles behavior could be viewed dynamically. The program allows to set problem situations from which students can leave. This implies pedagogical choices by the teachers. It is expected teachers propose an use of the program that encourages students conceptual restructuring. It is expected, for example, that teachers exploit the program to introduce situations such as forecasts-observations-discussion, in order to enable the students to highlight their views.

The resource, even if in French, has an high pedagogic value and is really worth to be pointed.

9) Food Education

http://www.softwaredidattico.it/EducazioneAlimentare/?/ai000000h.html

This site deals with different contents about food and can be used by pupils with no specific prerequisites. It is also useful as individual resource to deepen the knowledge of the related contents, because it provides numerous explicative texts dealing with different subjects (food, nutrients, hygiene, food labels....). The interactive section of this site (games) enables the user to evaluate his skills or the effectiveness of the learning thanks to the reading of the explicative texts. Each game allows to get immediately the feedback and, if necessary, to go back to the related explicative text.

A nice use of this resource can be done by organizing a scientific 'treasure hunt' in the following way:

- to propose open questions about digestive system and nutrients, to be answered by consulting the site
- to propose a final question connected with the previous open questions

The resource received 1 comment agreeing that it is a very useful site which gives teachers the possibility to employ new interesting teaching methods for approaching the subject of nutrition from many different points of view and, at the same time, maintain an increased level of interest from their audience.

10) Labchimica Itas Santorre di Santarosa

https://sites.google.com/a/santorre.it/labchimica/home

The resource is the chemistry section of the website of an Upper Secondary Institute (IIS: linguistic-human sciences-biotechnology technician): the prerequisites are those for the access to a superior secondary school. It contains:

- interactive simulations on batteries
- didactic material proposed by Santorre di Santarosa Institute teachers which can be downloaded by the students.

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- presentation of the project LabeBook , with corresponding link and guide.
- 'tutorial' section: it hosts guides on the use of applicative tools for the teaching of scientific topics. First tutorial is a guide on the representation of molecular models by RasMol. RasMol is an application for visualization and manipulation of molecular models, useful to work with organic macromolecules (proteins, enzyme, etc.) but also to study functional groups on small molecules.

It is a good resource for the possibility of be used by both teachers (work in classroom and experimental activities) and students (personal study and deepening).

11) Leonardo-Museo Scientifico Interattivo Virtuale

http://zitogiuseppe.com/blog2/indice-visuale/concetti-base/

It is a site targeted for upper secondary school. The site is plenty of contents in scientific topics: statistics, mathematical analysis, geometry, chemistry, physics, quanto-mechanics, nuclear physics. The menu is composed of pages equipped with links and applets related to the corresponding matter. Each of them is divided in the following sections: "introduction", "things to do" (to see the applet functioning), "what happens" (explication of the phenomena), "comments", "links and applets related", "author", "title", "website", research of pages carrying other links referred to the same matter. By opening links and applets, the pages appear ordered in an exhaustive list according to the chosen topic with recall to other links or scientific websites.

By taking into account the tremendous plenty of resources in the different scientific disciplines, it can be use in class for chemistry and physics courses in order to describe and visualize a large variety of related phenomena

12) Luce Virtuale

http://www.lucevirtuale.net/index.html

It is a proposal of interactive laboratory devoted to the study and comprehension of the light nature and properties and to the interpretation of electromagnetic phenomena. It provides:

- virtual experiments, history, references referred to the concept of light in classic and quantomechanic physics
- some exercises already developed on the topics.

The resource has an excellent pedagogical level: the resource can differently used by the teachers in the work in class or directly by the students for personal deepening

13) Materials for special uses

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
  - 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

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categories of materials are discussed in a concrete way, by focusing on practical properties and behaviour, without penalizing the scientific strictness.
The resource received 2 comments according on the innovative feature of the resource. 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.

14) PhET
http://phet.colorado.edu/it/simulations/category/chemistry
The website is provided by the University of Colorado and offers many interactive simulations in 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 10 comments from partners. 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.
- 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 network of teachers and experts.

15) Physical Chemistry Virtual Lab
http://www.chim.unipr.it/virtual-lab.htm
This program is a virtual laboratory that allows high school students to play some experiences of physical chemistry:

- measurement of the vapour pressure of a pure liquid as a function of temperature
- determination of the composition of a binary mixture in equilibrium at constant pressure using refractometry measures
- conductivity Measurements of strong electrolytes
- determination of the dissociation constants of an acid (or base) using potentiometric measurements
- measurement of heat of combustion of an organic substance by operating at constant volume
- measurement of heat of reaction at constant pressure
- measurement of f.e.m. of a stack

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To practice of laboratory activities without being present in a real laboratory. A virtual lab cannot substitute the real laboratory but it can help students to apply and remember chemical concepts that, otherwise, they consider as abstract and difficult.

16) Portale eniscuola.net

http://www.eniscuola.net/it

It is a website aiming to give teachers and students extensive information about energy and environment issues. In the home page, opening the grey links in the higher bar, you can find documents, pictures, graphs, charts, experiments and interviews about these 7 subjects: Energy, Air, Water, Earth Life, Ecosystems, Space.

For each subject there are 4 “focuses”: Sustainability, Games and quiz, Multimedia, Appointments and news. In particular Multimedia (Mediateca in Italian) offers a lot of interesting videos and experiments that could be useful in class, either in primary or in secondary school. The texts and vocabulary quality is instead suitable for pupils of secondary school (in the first and second grade); for primary school you can download a pdf format file (the junior version), but it is a single page that summarizes the several resources available for higher levels of school.

17) Tavola Periodica degli Elementi

http://www.tavolaperiodica.unicam.it/

The site consists in an interactive periodic table. The amount of notions provided by the site involves a considerable variety of chemical concepts. They range from the simple density of substances (macroscopic quantity) to the electronic configurations attributed to neutral atoms (microscopic properties). Particular evidence is given, as it should be, at the chemical transformations of simple substances.

The information that can be found in this Periodic Table allows to reason about the criteria which are the source of this great and unique classification. This purpose, is also emphasized by the historical development of the Periodic Table.

The movies about the chemical transformations are particularly appreciable, which are difficult to do in the classroom. They are not only curious, but they could be used as a problematic situation. The links to other site about the same subject are noticeable.

18) Virtual experiment: viscosity explorer 2012

http://www.planetseed.com/flash/science/lab/liquids/visco_exp/en/viscosity.htm?width=620&height=500&popup=truein

The Viscosity Explorer is a very nice and easy to use simulation about viscosity. It is targeted also for very young students, such as primary school students. It lets you see how viscosity varies from liquid to liquid and how temperature affects viscosity. You can compare two different liquids with each other and test the same liquid at two different temperatures.

In the page there are two containers in which you can pick (choose) a liquid between water, olive oil, ethanol, corn syrup, honey. Then you can set the temperature of the liquids (from 10°C to 90°C). When you click the DROP button, two steel balls drop into the liquids and you can see how fast they reach the bottom. Clicking on RESET, the balls go back in the grabbers and you can repeat the experiment.

The resource received 1 comment stating that the experiment is simple, well conceived and tested, and the focus on materials and properties of relevance in day-to-day life is a winning choice.

19) www.chimicamente.it

www.chimicamente.it

The site provides essentially:

- six simulations about acid-base titration, Brownian motion, simulation of gases, kinetics, thermodynamics, light-matter interaction
- an interactive periodic table
- two lessons on the nomenclature of compounds, with exercises (name-matching formula)

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- a page dealing with balancing equations of reactions
- a page that performs exercises on moles, grams, particles and concentration of solutions
- definitions of units of measure, various tables which may serve to integrate the books
- a voice "exercises done"
- "Games of chemistry" with 1998 Edition quizzes resolved and a link (PianetaChimica.it) where there are other quizzes related to other editions
- other material to be consulted (articles, lectures, etc.).

20) www.tavolaperiodica.it

www.tavolaperiodica.it

It is an interactive periodic table. The elements are described according to the typical systematic classification in groups and period. The properties of the elements are described together with some historical, commercial and general interest information. A section is dedicated to ores, with explanations of some metallurgical reactions to obtain pure metals from ores. Information are very often enhanced by author self-made movies, showing experiments.

5.2 Testing of teaching resources

The workgroup started an exploratory study aimed at evaluating the impact of few selected ICT teaching resources on pupils of different ages and schools. The preliminary step of the research (preliminary testing) was aimed at highlighting the ideas that an interactive resource arouses on students non-used to this kind of scientific tutorial, that is mainly the emotional impact and the instinctive reaction. The next step will be devoted to investigate on the effect that the same resources will have on learning and motivation, but this will require at least one year of experimentation for result that can be considered reliable.

Method, instrument and procedure of preliminary testing

The setting is the computer lab and the procedure foresees four steps:

- At the beginning, the pupils, grouped in pairs, surf the resource (website or simulation) freely and without teacher guidance.
- Then, the teacher indicates some website sections considered important (e.g. simulation, evaluation test, video, etc.) to be sure that pupils can arise an opinion about them.
- Finally, pupils surf autonomously again, discussing each over about the website features.
- At the end they are requested to answer a structured interview focused on the following progressive key points: interesting, learning, interacting, critical thinking [12-15].
- As first ICT resource, a virtual experiment on viscosity (viscosity explorer 2012, resource n°18) has been tested on kids attending the fourth year of primary school (24 kids, 9 years old).
- The experiment consists in dropping a ball through different liquids (water, oil, honey...) then observing its speed; it is possible to change liquid temperature by heating with a flame or cooling. Two simultaneous droppings are carried out, after choosing the liquid and the temperature, thus comparing viscosities as function of temperature and substance.

Data analysis

After the experience pupils have been interviewed: the questions and a synthesis of the answers are reported below.

Website interest

a. Is the website interesting?

Yes, because it helps to learn – Yes because it teaches interesting things – Yes because it helps to understand science – Yes because it makes you understand because when the ball drops in the

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honey it goes slower than in another liquid – Yes because we experienced liquids at different temperatures.
b. Which sections are more interesting?
To watch the speed of the ball - Honey, because when it is cool the ball drops slowly, but it is also interesting to watch what happens after changing liquids – Video – Two different substances at different temperature that drop with the same speed – The behaviour of substances at different temperature – The ball dropping – The flame that changes liquid temperature because raises or lowers the ball speed.
c. Which parts (texts, pictures, video, ...) are more interesting?
To change temperature – To change liquids – To drop the ball, because it shows the behaviour of liquids: The experiment is like a game, that makes you learn the behaviour of substances when you change their state :The ball, the flame, the liquids – The reset function, because you can repeat the experiment at different conditions – Oil with oil, or the same liquid at different temperatures, or different liquids at the same temperature.

Contents learning
a. Do the site help you in remembering the contents or it would be similar with a book?
The site is better because it shows the motion, the book shows pictures only – The site helps more because I see images – Books are more accurate – The site helps to remember topics already studied – A book states that liquid viscosity changes when you change temperature but the site shows me that the ball drops slower or faster.
b. Is the website structured in an easy way for your understanding?
Yes because it has many options – Yes because it helps us to understand the behaviour of liquids – Yes because it says what to do – Yes because you can understand well what to do e you can do many things – Yes because of pictures – Yes because it has a few things to do.
c. Which parts (simulation, video, pictures,...) support your learning better?
The ball, because when it drops you understand the behaviour of liquids at different temperatures – The video – Pictures in motion – Liquids – The possibility of select the same temperature but different liquids, thus observing the different speed of the balls – Oil compared with oil at different temperatures.

3. Meaningful interaction
a. Does the website stimulate interaction with your schoolmate?
So and so because they are distracted by the experiments – Yes because it helps us to agree – Only when you have to decide what to change – Yes because we help each over when we decide to change something – Yes because we find it very interesting.
b. Which parts stimulate more discussion with your schoolmate?
The ball, because it drops many times – The video – Chemistry, because there are many substances – To change temperature and substances thus observing differences – The liquids and the temperature – To see oil at 100°C and at 0°C – The ball dropping makes you understand temperature.
c. The discussion has been concentrated on the chemistry topics or not?
Yes – Yes because substances are chemistry – Yes, about liquids and temperature
4. Critical thinking
a. Does the website help you in understanding the real world?
Yes, because it shows the behaviour of substances – Yes, because it deals with things of the world – No – I don't know – Yes, because you discover new things.
b. Which are the parts that suggest you critical issues?
None – Texts, video and pictures – The ball in motion through the liquid – The liquids, because they are different – The video, that makes you discover the behaviour of substances.
c. Do you think that you will be able to explain the chemistry contents better after surfing this website (argumentation)?

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Yes – Yes, because now we know more about chemistry and about the behaviour of liquids when temperature changes – Yes, because we learn more things – Yes, because we consulted it with attention.
The first step of individual approach to the resource has been exploratory, but almost all the children discovered what was more interesting in the site, then it has been easy for the teacher to guide them to a functional exploration of the same. At this time, knowledge previously built a school, even long before, emerged.
Children initially were attracted by the 'game' but later a different interest arose. It led them to use the tool to test and study the phenomenon.

Discussion
Finally, we indicate some educational suggestions that arise from the first observations:

- how to use an Internet resource? If a teacher uses a digital tool, learning does not improve automatically; it is convenient to identify the most suitable sections so the students can use them, at least initially, with a good guidance by the teachers. In this manner, the students do not surf in a haphazard way [16,17];
- the meaningful discussion among the students does not start immediately; also in this case, the teachers should arrange some leading questions that helps the students in developing critical issues and discussion [18];
- the critical thinking is the most difficult aspect; we should calibrate and modify the research instrument [19];
- a further key point is related with the teacher education: we should consider the opportunity to educate teachers in using the internet resources in the classroom; it's necessary to identify and underline the crucial sections of the resource (this is both a design activity of the teacher before the experience in the classroom and a discussion activity with the students during the experience in the classroom).

A development point for further studies is as follows: how to create and build new resources in a shared (with the students) and easy way (with applications that also non-expert teachers can use)?
Obviously, we should verify these data with a larger number of participants.

6. Workshop

The workshop was held in Genoa, in September 10th 2012, at the Department of Chemistry and Industrial Chemistry. All experts and teachers actively participated in this meeting whose main topics of discussion were:

- the international papers on students' motivation;
- the teaching resources selected by the project partners;
- the use of ICT teaching resources to enhance students' motivation.

They all discussed sharing their skills and their experience in order to get the most useful information and suggestions from the material uploaded on the project portal.
Every teacher and every expert commented 1 paper and 1 teaching resource chosen among those uploaded by Partners on the Project Portal. In order to get the evaluation of all papers and resources proposed by the other Countries, the latter have been divided so that each teacher and expert had to analyse 3 or 4 papers and about 10 teaching resources and to choose the most valuable amongst them.
The list of papers and resources that have been presented and commented is reported below:
- Valter Bennucci (upper secondary school teacher)
Paper: A study of students' level of understanding of the particulate nature of matter at secondary school
Teaching resource: Chemistry experiment simulations and conceptual computer animations
- Caterina Bignone (primary school teacher)

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Paper: Rocard report: "science education now: a new pedagogy for the future of Europe"
Teaching resource: Science Kids – Chemistry
- Giuseppina Caviglia (primary school teacher)
Paper: Popularity and relevance of science education literacy: using a context-based approach
Teaching resource: Science children
- Elena Ghibaudi (expert)
Paper: Questioning patterns and teaching strategies in secondary education
Teaching resource: The Macrogalleria
- Antonella Lotti (expert)
Paper: How children learn
Teaching resource: Learn chemistry by Royal Society of Chemistry
- Enza Lucifredi (upper secondary school teacher)
Paper: A scientific approach to the teaching of chemistry
Teaching resource: An introduction to chemistry
- Barbara Mallarino (primary school teacher)
Paper: Identification of difficult topics in the teaching and learning of chemistry in Irish schools and the development of an intervention programme to target some of these difficulties
Teaching resource: Chemistry at Steve Spangler science
- Giorgio Matricardi (expert)
Paper: The problems with science education: “the more things change, the more they are the same” (Alphonse Karr 1808-1890)
Teaching resource: Chemistry stimulus to engage - discover sensors
- Davide Parmigiani (expert)
Paper: What’s wrong with Leaving Cert chemistry?
Teaching resource: Iniciación interactiva a la materia
- Anna Pitto (upper secondary school teacher)
Paper: Attitudes toward chemistry among 11th grade students in high schools in Greece
Teaching resource: PARSEL (Popularity and Relevance of Science Education for Science Literacy)
- Marco Rametta (upper secondary school teacher)
Paper: Bulgarian school chemical education: the state of the art, what then? (results from international and national studies)
Teaching resource: Las mujeres en la física y química-Quimicaweb
- Ilaria Rebella (primary school teacher)
Paper: Junior Science: teaching and learning: science education in the 21st century
Teaching resource: Chemistry for junior: Sci-Spy
- Alberto Regis (expert)
Paper: Students’ motivation and chemistry teaching. A controversial point
Teaching resource: BBC school science
- Silvana Saiello (expert)
Paper: Students' motivation in secondary school chemistry teaching using common life tasks.
Teaching resource: IrYdium Chemistry Lab
- Nadia Zamboni (lower secondary school teacher)
Paper: Greek students’science-related interests and experience: gender differences and correlations
Teaching resource: Chemistry at home
- Rosalia Zunino (primary school teacher)
Paper: Science education in Europe: critical reflection
Teaching resource: E.K.F.E. Chanion

During the comments presentation few important points have been discussed and suggestions to improve the future activities have been produced. The main results of the discussion are summarized below.

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- The problem of low student motivation in studying chemistry is a problem common to the most of European Countries. They are well aware about it, as documented by several papers uploaded on the project portal. 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.
- 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.
- 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.
- 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.
- 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.
- 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.
- On the base of the above observations, all participants agree in concluding that although some selected resources are of good quality, they are not optimal, especially those addressed to the younger students. Therefore it would be good if every Partner will project at least one resource both national language, using the selected material as reference. For this aim, the defects will be corrected, the most positive aspects will be optimised and the contents will be integrated.
- At the end of the meeting it has been decided that the most valuable national resources, along with few foreign ones, will be proposed to students of different schools. Moreover, a questionnaire will be prepared and used to assess the effect of these ICT resources on students' motivation.
- It will also be estimated if the use of the above ICT resources will improve the learning of the scientific contents and if they can be adopted as valuable tools to integrate the more classic lessons. This kind of assessment needs much longer times, therefore it will be carried out at the end of the school year.

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7. Conclusions

The first year of the project was devoted to analyse the situation about students' motivation in the study of chemistry, not only through documents and national reports, but also through the personal and valuable experience of teachers in schools of each level and experts involved in research about 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, promise to have a great effect on science education.

It is our intention that the join effort between teachers and experts, that in the case of our network showed to be useful and successful, will continue in the years following, even after the end of the CIAA-NET project. It will be useful, we hope, to build concrete teaching methodologies and training paths that start from primary school and that help the student throughout his school career.

The possibility to share efforts and experiences also with other European Countries has been really positive. As we could verify, the problem of low students' motivation in the study of chemistry is diffused in all over Europe, and each Government tries to find solutions funding projects or encouraging numerous initiatives: but it is not enough. As underlined in paragraph 4.2 motivation cannot be confused with the term enthusiasm, because it is something deeper, much more difficult to obtain, but long lasting and much more productive. It is something that can be obtained only changing the classic teaching methodology, thus placing both student and teacher as protagonist of the learning process.

The most important goal of the first year of project has been the selection of ICT resources to teach chemistry and the possibility of using them as tools to enhance students' motivation. Even if these kinds of resources have to be chosen very carefully and cannot be considered as substitutes of more classic activities (laboratory, textbook, classroom lesson...) or of the teacher, they are valuable tools to integrate the teaching, also because very friendly with the new generations of pupils (the 'digital natives).

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References

[1] From Eurypedia https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Italy:Teaching_and_Learning_in_General_Upper_Secondary_Education
[2] OECD, Organization for Economic Co-operation and Development (2007). PISA 2006: Science Competencies for Tomorrow's World. Paris, OECD
[3] http://www.invalsi.it/invalsi/index.php
[4] http://www.chemistry-is.eu/
[5] MIUR, Ministero dell'Istruzione, dell'Università e della Ricerca (2010). Il piano 'Insegnare Scienze Sperimentali'. Annali della Pubblica Istruzione. Florence, Le Monnier
[6] MIUR, Ministero dell'Istruzione, dell'Università e della Ricerca (2007). Il progetto 'Lauree Scientifiche'. Annali della Pubblica Istruzione. Florence, Le Monnier
[7] MIUR, Ministero dell'Istruzione, dell'Università e della Ricerca (2011). Piano Nazionale Scuola Digitale. Annali della Pubblica Istruzione. Florence, Le Monnier
[8] Gordon D.T. (2000). The digital classroom: How technology is changing the way we teach and learn. Cambridge: Harvard Education Letter.
[9] O'Reilly T. (2005). What is Web 2.0?: Design patterns and business models for the next generation of software. Retrieved January 31, 2011, from http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html.
[10] Parmigiani D., Cerri R., Lupi V., Ghezzi E. (2010). Cl@ssroom 2.0: how to improve the learning environment through ICT and web 2.0. In ATEE Winter Conference Proceedings: Early Years, Primary Education and ICT – vol. II, Prague, Czech Republic, February 26th-28th, 2010, pp. 100-113.
[11] http://gold.indire.it/gold2/
[12] Garrison D.R., Anderson T., Archer W (2000). Critical inquiry in a text-based environment. Computer conferencing in higher education. Internet and Higher Education. 2 (2-3), pp. 87-105.
[13] Brown A.L., Campione J.C. (1994). Guided discovery in a community of learners. In K. Mc Gilly (ed.). Classroom lesson: integrating cognitive theory and classroom practice. Cambridge, MA: MIT Press, pp. 229-270.
[14] Andriessen, J. (2006). Collaboration in computer conferencing. In A.M. O'Donnell, C.E. Hmelo-Silver, & G. Erkens (Eds.), Collaborative learning, reasoning, and technology (pp. 197-231). Mahwah, NJ: Lawrence Erlbaum Associates.
[15] Strijbos, J.W., Martens, R.L., & Jochems, W.M.G. (2004). Designing for interaction: Six steps to designing computer-supported group-based learning. Computers & Education, 42, 403-424.
[16] Hmelo-Silver, C.E., Duncan, R.G., & Chinn, C.A. (2007). Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Clark (2006). Educational Psychologist, 42 (2), 99-107.
[17] Kirschner, P.A., Sweller, J., & Clark, R.E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. Educational Psychologist, 41 (2), 75-86.
[18] Parmigiani D., Pennazio V., Panciroli C. (2012). Lo sviluppo della collaborazione in classe e in rete. Il ruolo del web e delle tecnologie 2.0. RicercAzione, 4 (1), pp. 21-35
[19] Parmigiani D., Pennazio V. (2012). Web and tool 2.0 affordances for formal and informal learning strategies: the role of the educational project. REM-Research on Education and Media, 4(1), pp. 71-84.

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