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CHEMISTRY TEACHERS' TRAINING IN ITALY

Lifelong Learning Programme

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CHEMISTRY TEACHERS' TRAINING IN ITALY

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ABSTRACT

The first part of the report is devoted to present the Italian organization as regard to science/chemistry teachers: certifications required and training courses, both pre-service and in-service training courses. An assessment about this organization is given taking in consideration objective aspects but also the opinion of teachers. For this aim "junior" and "senior" teachers were interviewed about their past and present training and about what they need to improve their skills. The second part of the report is dedicated to present the impact of the project on teachers' training. In particular, the impact on teachers involved in the project is significant and it is described in detail through the activities they carried out, even not foreseen by the project but linked to it. Finally, emphasis is given to the role of associated partners, needed to disseminate the project at national level and to sensitize the government bodies to address more attention to the teaching of chemistry at school and to the training of teachers.

1. National situation on teacher training

Initial teacher training is actually provided by the Ministry of Education, University and Research (MIUR) for both primary and secondary school teachers.
Primary school teachers have to get the degree in "Sciences of Primary Education". This degree program consists of two addresses: one for the training of nursery teachers and one for primary school teachers.
The degree in a specific discipline is the first requisite to teach at secondary school, but it is not the only one: a one-year postgraduate course, named TFA (Active Formative Training - Tirocinio Formativo Attivo), has to be attended in order to get a teaching qualification. This qualification is compulsory, even if not sufficient, to get a permanent role of teacher at school. Without it, only temporary contracts, can be obtained.
For what concerns in-service training, it is sporadic and not compulsory. The most significant are national projects financed by the Ministry of Education, University and Research (MIUR) and provided by Universities, or courses provided by INDIRE (National Institute of Documentation for Innovation and Educational Research) [1] with the support of European Structural Funds (FSE).

1.1 Initial teacher training

Science education in Italy [2,3] begins at primary school as a single, general, integrated subject area, where broad themes which are the basis of chemistry and other scientific disciplines (states of matter, vegetable world, human body etc.) are taught. Integrated science subjects promote a questioning and investigative approach to the environment and prepare children for more detailed studies in later grades.
The teaching of science continues as an integrated program at the lower secondary school and splits into separate subjects at the upper secondary school, but not completely. In fact, after the recent reform of the school system (introduced with Law no. 53/2003 and the subsequent decrees), the teaching of science at the lyceum foresees two disciplines, physics and natural sciences: the teaching of natural sciences includes biology, chemistry and earth sciences, grouped in an integrated program.
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.

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In order to be included as science/chemistry teacher in the above school system, the training is different as function of the school grade.
As above mentioned, primary school teachers have to get the degree in “Sciences of Primary Education” . Access is limited and the number of enrolments is established in each region according to the needs of schools; the admission examinations test the knowledge of the main disciplines. The course takes five years and provides both disciplinary teachings (language and literature, math, sciences, history and geography) and didactic-pedagogic teachings; also didactic-pedagogic laboratories are foreseen, and a traineeship carried out in the school alongside an experienced teacher.
For what concerns lower secondary school, chemistry is taught within and integrated program (sciences), including natural sciences and physics, and the teacher is also the math teacher. Accordingly, in order to teach sciences and math at lower secondary school, it is needed to get a generic scientific degree as math, physics, biology, natural sciences, chemistry, informatics etc.
A little more specific is the request at higher secondary school: only people graduated in chemistry, pharmacy or chemical engineering can teach chemistry where it is foreseen as a separate subject. But at the lyceum, natural sciences, as it is an integrated subject, can be taught by people graduated in natural sciences, biology, geology, chemistry, pharmacy and few others.
Before 1999, the degree was the only compulsory requisite to teach at secondary school: after this data, a post-degree two-year master (Training Course for Secondary School Teaching - Scuola di Specializzazione all’Insegnamento Secondario – SSIS) was instituted as a pre-service education for secondary school teachers, and was specific for school grade and discipline, including chemistry. In 2008 SSIS was interrupted and only in 2012 it was re-established, as one-year course: TFA. The first cycle of TFA finished the last July: chemistry teachers for upper secondary school and math and science teachers for lower secondary school got the qualification.
TFA foresees a limited number of attending people for every year, admitted after an examination testing the knowledge of the specific discipline.
It provides didactic-pedagogic courses, together with courses and laboratories about the teaching of the discipline, organized by the universities. More specifically:

- courses about special pedagogy to apply in presence of students with different problems (disturbi dell’apprendimento, handicap, social disease ...)
- courses about general aspects of the education at school: communication, didactic mediation and relation
- courses about the instructional design and some teaching methodologies such as cooperative learning and problem based learning
- specific courses about the didactic of chemistry, including the laboratorial approach
- courses about the use of ICTs at school

Finally, a period dedicated to practical experience at school, side by side with an expert teacher, the tutor, is foreseen to complete the training.
An examination is foreseen at the end of each course and the final TFA score is the somma of the single voti. This score influences the position in the graduatoria of new teachers

1.2 In-service teacher training

The in-service training of teachers, as mentioned in the first paragraph, is sporadic and not compulsory. For what concerns scientific disciplines, it is mainly provided by national projects funded by the MIUR. The Scientific Degrees Plan (PLS) is, actually, the most active and widespread project at national level [4,5]. It is addressed to upper secondary school and financed from the Ministry of Education since the first edition, in 2005. The project was born to face the alarming decrease of enrolments to some scientific courses of degree: chemistry, mathematic, physics, science of materials; year by year, it realized a great success in improving the teaching-learning methodology in upper secondary school so as to become a reference point for many teachers.

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Piano Lauree Scientifiche

PLS-Chemistry aims to increase motivation to study this discipline, both by involving students in practical activities and by improving teacher skills. The major point of strength is the joint effort between school teachers and university researcher in a work of planning, production and validation of new tools for a more efficacious teaching of chemistry. Several universities are responsible for the project at local level and design activities autonomously, on the basis of teachers' requests and needs, of number of researchers involved, of skills etc.

More specifically, examples of activities that are carried out within the project involving teachers, so as to provide a form of continuous training, are:

- meetings for the production of tests (i.e. admission tests for the degree course in chemistry)
- seminars on current topics of chemistry or teaching methodologies;
- meeting to design practical activities to be carried out in the laboratory;
- implementation of laboratory activities with students

The part devoted to the laboratory is usually the most popular and attended, as for the enthusiasm of the students, as because teachers feel not prepared in this area and require help.

As PLS is a project and not a course, no examination is foreseen and a certificate of attendance is given to teachers.

The national program 'PON Science Education'[6], is part of a larger program dedicated to the training of teachers (PON 2007-2013). Its main objective is to improve the quality of science teaching in order to improve the level of science learning of students. This project is provided by INDIRE, a National Institution that has the task of accompanying the evolution of the Italian school system by investing in research, experimentation and innovation. With regard to teachers, INDIRE aims at improving the performance of teachers in their educational practice, in making school every day, through the provision of innovative solutions both from the methodological point of view, and from the contents, methodologies and technologies. The training model is blended, meaning that it integrates activities in presence and activities on-line. It is based on the 'situated knowledge', in order to accompany teachers from theory to practice, and on the 'cooperative learning' through a continuous dialogue between teachers, experts in education and e-tutors, in order to encourages the building of communities of teachers.

The course consists of 30 hours in presence, in a scientific laboratory, 35 hours of online training and 35 hours of individual design. During the lessons in the teachers are divided into groups, each supervised by a tutor, that perform laboratory activities. The latter activities are intended to be proposed to students afterwards. The same tutor also follows teachers during the lessons on line.

A little examination is foreseen at the end of the course and a certificate is given.

The teachers who attended the training in 2009/2010 have reported positive testimonials on the course about:

• the richness and innovativeness of activities performed

• the immediate continuing involvement of students thanks to the activities proposed, which made them protagonists in the experimental verification of the topics covered.

Piano ISS
Insegnare Scienze Sperimentali

Another project worth to be mentioned is "Teaching Experimental Sciences" (ISS) [7], even if recently expired for lack of funds. "Teaching Experimental Sciences" was addressed to teachers of primary and of the first two years of secondary school; it aimed to improve

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the methodological approach in the teaching of scientific disciplines recognizing the centrality of the student.
ISS had the final objective of enhancing the scientific literacy of Italian students, above all by providing the continuous in-service training of teachers and promoting, by the work of the teachers themselves, important scientific educational experiences and practices. In other words ISS aimed to enhance learning through the improvement of teaching. The main project activities consisted in a continuous educational research (research-action) made by teachers, experts and researchers. Teachers chose the contents to develop, then design and carry out new practices with their students. The new practices were assessed on the base of students' response and learning, were shared with other teachers, were discussed with the experts and, if needed, were corrected and tested again.
A characteristic of ISS plan was the implementation of laboratory didactics mainly intended like laboratory of the mind, as a tool to accompany students through the experience of the experimental research, that foresees discussion, critical analysis and the possible crisis of the protocol itself. In this modern perspective, teacher is no longer the person who says what to do and explains the contents of a discipline, but is a guide accompanying the student through the construction of his knowledge, by the critical analysis of what he sees and the discussion with his peers.

2. Assessment of the National Training of Science Teachers

Chemistry is recognized by students as one of the most difficult and boring subjects and too often the responsibility of students' low motivation and performance is assigned to teachers. As a matter of fact, they are considered experts of the discipline, but unable to present it under a more capturing light, or to explain the abstract contents in a more suitable way. It's a common opinion that they should continuously update their teaching methodology, by using different approaches and tools, in order to satisfy the needs of each student and the changes in society.
These statements cannot be shared by people that work in the field of education and know too well that teachers, not only chemistry/science teachers, do not often receive an adequate preparation and find it difficult to deal with colleagues.
Teachers, and much more science teachers, cannot be trivial dispensers of information but must become professionals with specific and synergic skills:
- Disciplinary skills. This is a necessary, but not sufficient condition.
- Educational skills related to their discipline. These skills are needed because they make teachers able to plan and cope with learning situations.
- Pedagogic skills. In order to face the complex social and psychological problems that arise within the class.

In particular, special care should be paid in order to improve the communication with students and the use of the laboratorial approach.

2.1 The problem of the communication

The primary task of teaching should be to identify the conditions that can make communication effective; in other words, the most appropriate conditions to minimize the difference between what the teacher means and what the student perceives. This is particularly difficult when the subject taught is chemistry, because of the relationship between the macroscopic and the microscopic models and of the necessity of using symbols.
Three main contents are involved in communication at school [8]: the language, 2. the requisites, 3. students' interest and motivation
The language
Teachers should take the language into a great consideration, despite the discipline they teach: they should use, as much as possible, words of the

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common language, at least initially (it means starting from the language of their pupils), and, at the same time, they should work to enhance the linguistic skills of their students. Pupils' linguistic problems occur from the beginning of primary school, since the very first day of school: It's when the kids realize that some topics are difficult for them to get through and, thinking they won't be able to understand, they will rather use their memory than their brain to learn. This somehow inevitable choice, is irreversible because if the pupil gets good results by memorizing and repeating, he will continue and become increasingly able at this feature; memorizing requires less effort than understanding, and students will hardly choose this option, particularly those who have never been purposely trained.

The requisites

When the addressees of a message haven't got the necessary requisites to interpret it, this creates problems in communication. In this case, we refer to the conceptual requisites, skills and abilities that are essential in order to understand what is being proposed. For this reason the choice of contents becomes an extremely important factor in school, a factor often overlooked in favour of the method. The method is certainly important but so is the quality of the contents that the teacher offers, as there are contents that need multiple requisites and contents that require the possession of fewer requisites.

The motivation

Once the teacher has created adequate conditions so that the message is understood as the teacher wants, there is the problem of passing from the so-called comprehensibility of the message to its proper understanding by the recipient. Interest and motivation are factors that influence the transition from comprehensibility to proper understanding. As a matter of fact, there is a strong relationship between learning and interest in learning: it could be argued that if pupils have no reasons to understand, the learning will be very hardly achieved. It is necessary to identify appropriate tactics and strategies to attract the students' interest, to make sure that they feel the need to "look for explanations."

Explanation is strongly connected with problems in communication and it's useful to spend some words to clarify its meaning and role [9].

An explanation about scientific subjects can be really considered as such, only if the pupils are able to understand it, otherwise it loses its educational value. The teacher, therefore, must always calibrate his/her didactic proposals taking into account the requisites of his/her students: only when the explanation takes into account the cognitive level of the recipients, it can establish a functional communication towards learning. Moreover, it is necessary that teachers, as well as their pupils, are able to distinguish between the explanation of a phenomenon and its description.

Unfortunately, the training that many teachers have received did not favour the acquisition of a critical and reflective behavior: during their teaching activities they tend to repeat to their students the same 'explanations' stored or partially understood when they were students. As an example, we can consider the transition of a pure substance from the solid to the liquid state: this is a familiar phenomenon and therefore, being erroneously considered simple, it is treated with excessive superficiality also from textbooks that often provide explanations that do not really justify the macroscopic behavior.

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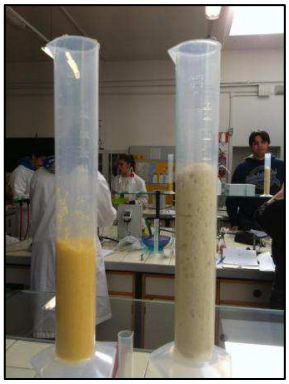
2.2 The need of a laboratorial approach



The laboratorial approach is a very useful tool for teaching to develop the cognitive autonomy of pupils [10]. It is a methodology that valorises the experimental approach to problem solving and enhances its educational potential. It foresees a sequence of actions where the student is not a banal performer that follows the instructions of a recipe, but a person who reflects about the way the experiment should be carried out, performs it, collects data, analyses the results and communicates them. This way of working allows to raise the logical-linguistic skills of pupils, the ability of evaluating their knowledge and the ability to relate to others. Everything can happen only through a systematic request of expressing their points of view, compare them with their classmates' and verify their claims.
The operative sequence to follow during a laboratorial path is the following:
- focus on the specific topic that will be dealt with, through the description or presentation of an experience (this applies in particular to the experimental sciences) or a short written text (this approach is used for all disciplines)
- individual written work: each pupil has to express his point of view about the topic. The work has to be performed by the use of a worksheet where the teacher clearly indicates what is requested by the students. The task usually consists in one or more specific open questions
- written work made by small groups (on another related worksheet): pupils compare the individual answers and try to reach a unique shared answer. Should different points of view persist, they must be written
- presentation of the conclusions by the representatives of each group; the teacher will try to build up a summary of the results
- teacher's considerations about the topic dealt with, additional information and suggestions.

From the above discussion, we can deduce that the laboratorial approach is not trivially a practical experience that students carry out in the lab by following a pre-constituted recipe, but it can consist in a more complex path. Following this methodology, the experimental approach to scientific problem solving consists in designing and performing an experiment, collecting data and analysing results, but also in enhancing pupils' ability to express their points of view, to compare them with those of their fellows and to reflect about what they have done and thought during the activity. In this way pupils increase their self-esteem, their cognitive autonomy and their metacognitive skills.
Finally, it is worth underlining that, if we want motivational aspects, laboratories and other educational tools have a positive role, it is indispensable to realize an efficacious communication by choosing suitable contents. Only if the recipients possess the necessary cognitive requirements and the transversal basic skills, the new knowledge can interact with what they already know.

2.3 What teachers think

In order to add more concrete considerations to the national report, some teachers were interviewed about their past and present training and about what they need to improve their skills. In particular, two categories of teachers were consulted:

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- "junior teachers", meaning people that attended the TFA for chemistry (upper secondary school) and got the qualification in July 2013. They have few years of experience in chemistry/science teaching, but only with temporary contracts
- "senior teachers" , meaning upper secondary school science/chemistry teachers with many years of experience.

Junior teachers think that a deep knowledge of chemistry is necessary but not sufficient to be a good teacher. Therefore, they appreciated the contribute of the TFA to their training, in particular for what concerns the courses about pedagogy and science of education and about special teaching methodologies such as the teamwork or the use of ICTs; much appreciated was also that part of the course dedicated to the laboratorial approach. Some critics were addressed to the poorness of practical activities within the courses and to few aspects of the general organization.
In synthesis the evaluation was globally positive: they state that "the experience will be the real motor of the improvement in teaching, but the experience is not sufficient without a suitable training, initial but also continuous".
Senior teachers did not have initial training, apart the degree in a scientific discipline. Most of them teach science at the lyceum and have the degree in biology or in natural sciences. First of all they declare a low chemistry knowledge so feeling not adequate to teach this part of the curriculo. This situation is very diffused in Italy so to seriously threaten the survival of chemistry at the lyceum. Secondly, they recognize that the lack of an initial training made more difficult their work and they had to count on the experience only, day by day. But experience is not sufficient, so they feel the need of attending courses to improve the approach with students and to apply an efficacious educational mediation between students and chemistry. They thank the contribution that projects as PLS-Chemistry gave to their skills, and state that courses or events for teacher training should deal with the laboratorial approach, the chemistry of everyday life, the update of the knowledge with the state of the research and the new technologies. Finally they would like to have the possibility of belonging to teams composed by teachers and teacher trainers, that discuss the usual problems of teaching, that test solutions and produce materials to use with students.

2.4 Synthetic assessment

Italy provides a insufficient training to its science teachers, both with regard to initial training, that with regard to in-service training. Teachers themselves feel of not having good teaching , organizational, interpersonal and communication skills. Another, not negligible, problem is linked to the school organization: as explained in the first paragraph, chemistry is often taught by teacher graduated in other, even if scientific, disciplines.
In the light of this situation, the system of teacher education is evolving, but with great difficulty: a functional and well structured system seems to be very far from the reality, also due to the lack of funds. It is worth to be mentioned that activities addressed to teachers exist and are increasing because the need of teachers to be continuously trained is increasing too, but their are not sufficient to guarantee a well planned training.
Finally, in-service training does not influence the career of teachers. In fact, despite the issuance of certificates of attendance (sometimes after taking a final exam/test), courses and projects do not provides credits for carrier advancements or higher salaries. An acknowledgment is requested, because also teachers, not only students, need to find motivation to do their work better and better every day.

3. The Impact of the Project on Teacher Training

The national team involved in the project consists of 10 teachers and 6 experts; moreover, 7 associated schools are supporting the project because they are convinced that it is necessary to give greater dignity to the chemistry, just starting from the teaching of this discipline at school. For the same reason, 6 associated partners, some of them with an important political role, joined the project. The project is making a valuable contribution to the training of teachers because:

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- allows experts to deal with the international reality and increase their knowledge in the field of training
- allows experts to discuss with teachers of schools of all levels and degree, thus establishing a solid contact with the school, its problems and its needs
- allows teachers involved to have people to refer to for advice and improving their teaching methodology
- allows teachers users of the portal to update on the teaching of chemistry in Europe and find ideas for new teaching methodologies
- encourages the creation of new collaborations, not only among people involved in the project, but also with colleagues and teachers reached by dissemination activities.
- sensitizes people involved in the field of education to the need of improving the training of teachers to have students better prepared and motivated

In the following sections (3.1-3.3) we will present in detail the impact that the project had on teachers involved, who attended with profit and satisfaction in different activities, some provided by the project, others linked to it but born on teachers' initiative. These activities are producing:
- new material for the teaching of chemistry that will benefit the teachers users of the portal
- new skills for teacher trainers in order to decrease the gap between university and the world of school
- new collaborations among teachers of schools different for location but also for order and degree.

Paragraph 3.4 is finally devoted to a brief presentation of the associated partners and their role in the project.

3.1 The workshop

The most important opportunity to meet is during the annual workshop. In this case the attendance is large: even the experts who live far away from Genoa are involved, so giving an essential contribution. The workshop is fundamental part of the project because it allows to:
- share and integrate the work that experts and teachers make for the project
- discuss and compare problems and experiences in order to improve everyone skills

The last workshop, held at the Department of Chemistry and Industrial Chemistry, dealt with teacher training, following six issues:
1) Methodologies to teach a specific topic: analysis and comparison between positive and negative experiences
2) Consequences of lack of opportunities to experiment different approaches and methods for teaching and learning chemistry
3) Importance of training science teacher keeping them updated with the continuous progress of the research
4) Use of simulations: pros and cons
5) Identification of recommendations, guidelines for teachers
6) Discussion about international papers and publications

Teachers discussed about textbooks and the indications for the curricolo that lead to teach too many subjects and in a premature way. One of the main difficulties is to have to introduce the atom structure even in the lower secondary school. A superficial teaching is one of the consequences of this approach as well as wrong concepts taught to the students. Short lab experiences are often used to help. Teachers realize that learning to use some types of ICT could facilitate to teach some difficult concepts, thanks to the displaying and the mobility of simulations. For example, some simulations of the site http://phet.colorado.edu/it/ have been tested by teachers (e.g. the simulation about molecular polarity and that about density) and gave good results.

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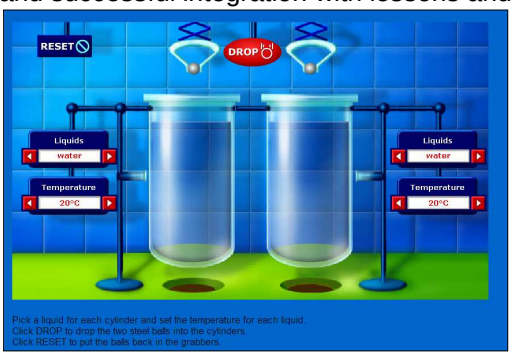
The cooperative learning has been discussed, because it represents an important resource to stimulate student participation and collaboration in order to get significant learning. It should be important also to have the opportunity to experiment different approaches and methods under the guidance of experts (both in the discipline and in psychology and pedagogy) in order to avoid numerous mistakes depending on the lack of experience.
The work group claimed the necessity of keep a strong link between the teaching and the progress of the scientific research. This updating is useful in order to keep in mind the context where the students will apply their knowledge and to give them suitable hints, ideas and connections with their life. Knowing the evolution of science and technology means to teach in a more critical way, being aware that the rules do not exist in nature, but we lives in successive approximations. They are models that are modified as the instruments of investigation become more sophisticated.
The discussion on ICT resources has highlighted the difficulties that currently schools have in using them. The first problem is that the number of computers is not sufficient to meet the guidelines of the Ministry of Education that encourages the development of digital skills; in some cases the internet connection is not available in the computer room. The second problem consists in the lack of teacher training to use digital tools and applications. Teachers feel obliged to use them but they do not know how make them effective for learning.
On the basis of the testing made by the teachers supporting the project, ICTs can be effectively included in the teaching-learning process because the student reaction has been positive and their interest seemed to be motivated. But, few words of caution: ICTs have to be included in a significant way in a wider learning path, because if they are used as detached objects they can produce negative effects (loss of time, distractions of the class, transmission of misconceptions...). In this way ICTs can be real teaching resources and not simple tools.
For this reason it was decided to produce guidelines for the use of ICTs that have been tested and those that will be tested in the coming months. These documents will contain suggestions for educational paths that can be followed and supported by the above ICT resources, tips and considerations from teachers and experts. They will be uploaded on the project portal.

3.2 Use of ICTs

Teachers belonging to the national team and to associated schools are contributing to select and validate ICT teaching resources, so learning to use this kind of tool, otherwise rejected
The validation of the resources was conducted by choosing those in line with the school curriculo and was carried out by the teachers, according to their sensitivity and in order to achieve an appropriate and successful integration with lessons and laboratory activities.



Viscosity Explorer [11] is an interactive simulation that allows to compare viscosity of two liquids after selecting the kind of liquid (chosen among olive oil, water, ethanol, honey and corn syrup) and its temperature: it is very simple to use and the run of the metal spheres dropping into the tanks gives a clear perception of the different resistance from fluids. English language does not limit the use of the simulation, even better, the presence of few common words enhances its usefulness because of interdisciplinary approach and encourages schools to recur to international resources, if valid. This tool was proposed by Giuseppina Caviglia to her class (fifth year of primary school): each student was already familiar with viscosity and used to learn through observation and practice. Pupils, divided into group, agreed on the variables to change time to time and discussed with the teacher about what was observed thus reinforcing concepts already known.
Alternatively, Viscosity Explorer can also be exploited for the purpose of discovery learning, letting the children through different explorations guided by the teacher, come to build their definition of viscosity and deducing the influence of temperature.

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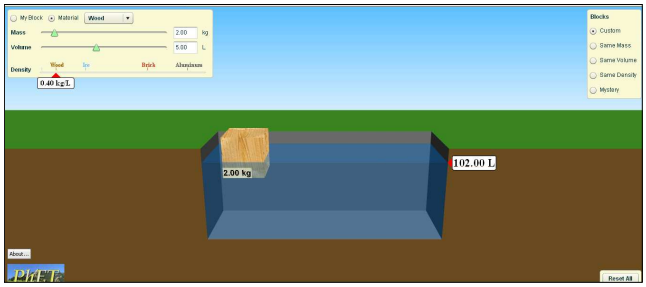
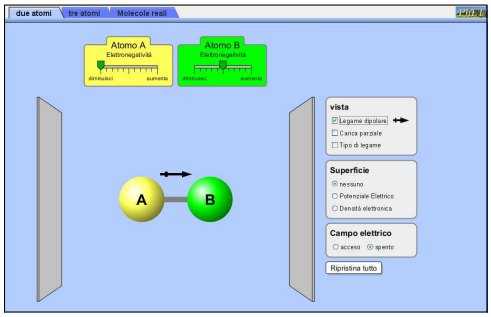
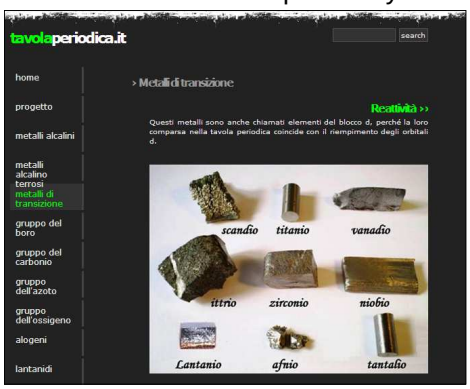
It can also represent the virtual completion of laboratory activities, carried out by manipulating different types of liquids, or the starting point to design, in class, practical activities, choosing appropriate parameters and materials.
Staying on the theme of simulations, we report a site very rich, not only for chemistry, organized by the University of Colorado: PhET interactive simulations [12]. The following resources from this site were used:
- density simulation: tested by Nadia Zamboni at the first year of primary school
- molecular polarity: tested by Graziella Battistin at the fourth year of scientific lyceum





Both of these instruments have been useful, thanks to the scientific rigor that characterizes them, the easiness of use and the possibility to change various parameters then detecting consequences.



The site tavolaperiodica.it [13] was chosen, among the many available on this subject, as an aid to the teacher who has to introduce, or even deepen, the elements and their properties. It is not an interactive periodic table, but a site, organized in a simple way through sections corresponding to the groups of elements, full of videos and pictures, informative texts written in an appropriate language to young students and curiosity regarding some elements. Tavolaperiodica.it was proposed at the third year of a scientific lyceum by Laura Ricco and Anna Pitto. Such as type of work, it was decided to divide the class into small groups and assign each exploring a section. This preliminary stage was followed by an oral presentation of the information collected, with integration / correction from the teacher on the basis of cognitive patrimony of the class.
Videos show chemical reactions that are difficult to carry out in the laboratory and are therefore useful to supplement more feasible practical activities that can be realized before; practical activity is essential in an experimental discipline such as chemistry and can not be replaced, but only accompanied / supplemented by virtual experiences, both for the difficulty in performing the experiment in total safety, both for the cost of rare materials or not commercially available in limited quantities. In this context, one can draw utility from movies that show behavior and characteristics of liquid nitrogen and mercury.
The program is interesting because it can be used at different levels: Roberto Antiga was inspired by the site for an exploration of the world of the elements and their reactivity. He worked with a lower secondary class (second year)
Nadia Zamboni used English resources in order to experience the CLIL methodology in building science and digital skills. The whiteboard gave an essential support because it favored the cooperative work, through continuous sharing moments between groups of pupils.

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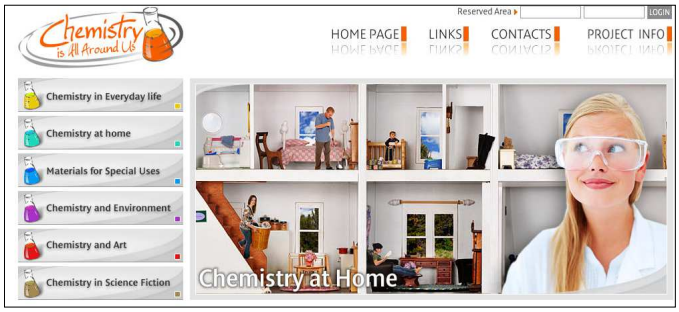
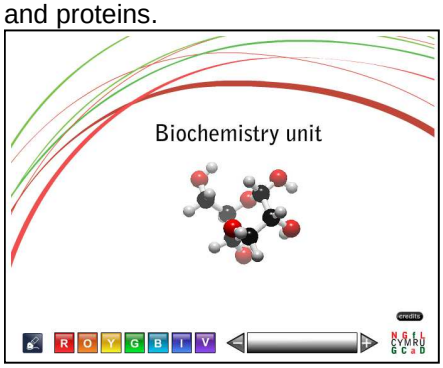


Chemistry at home [14], the interactive section of the site Chemistry Is All Around Us, provided interesting insights to undertake, with laboratorial approach, a path of observation and reflection on a common chemical reaction such as that between vinegar and baking soda. The students, divided into groups, have explored part of the resource, focusing on the reaction and collecting information on some factors affecting it. The English texts have also allowed an unusual approach to the specific terminology in a foreign language, which has become part of the learning process.

Each group, after choosing an experimental variable to be tested among quantity, temperature and concentration of reactants, presented the activity to the other schoolmates, in the form of self-managed project.

At the end of the activity, the teacher required a scientific report including both the work done in the first person and the one made by the other groups. The activities were also supported by the implementation of worksheets in Italian / English, provided by Nadia Zamboni and compiled by the students, again through a mode of cooperation extended to the entire class. The details of the work, carried out with a second class of lower secondary school degree, were recently published online [15] and are freely available.

The second ICT resource in English experienced by Nadia at the lower secondary school is Biochemistry Unit [16]. It is an interactive tool that can be downloaded from a learning platform by the Welsh Government; it is organized in seven activity levels of increasing difficulty and provides a great opportunity to build learning paths on certain categories of organic compounds: sugars, carbohydrates and proteins.



The sections considered most suitable for the lower secondary school (only three of the seven available) were used in the classroom after a brief introduction to organic chemistry with the whiteboard. Pupils accessed the interactive activities, working in pairs and progressively deepening knowledge. Also in this case the teacher provided worksheets and tests in order to integrate the learning path and stimulate students to reflect and comment on the new learning.

3.3 Birth of new collaborations

Teachers belonging to the national team and to associated schools have begun to work together in order to build teaching units also including ICTs from the portal. The first task force, created this year thanks to the project, includes:

Nadia Zamboni (lower secondary school teacher)
Roberto Antiga (lower secondary school teacher)
Anna Pavan (lower secondary school teacher)
Paola Argenti (upper secondary school teacher)

Moreover a new primary school teacher is going to be included in order to design vertical paths, from primary to upper secondary school, on the theme of materials and their properties.

This collaboration was born spontaneously, among teachers who believe in the importance of dialogue between colleagues and in the synergy that comes from the comparison and sharing of good practices.

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3.4 Importance of associated partners

Six associated partners have been involved in the project to day:

1.Comune di Genova, Dipartimento di Politiche Educative (Genoa Municipality - Education Policies Department). Municipality of Genoa provides local government of educational and social policies, according to the Autonomous Scolastic Institution of the city, through the governance body named Conferenza Cittadina delle Autonomie Scolastiche (City Conference of Scholastic Autonomies)

2. Divisione di Didattica della Società Chimica Italiana (Didactics Division of the Italian Chemical Society). The Division of Chemical Education is one of 11 divisions (areas of science discipline) of the Italian Chemical Society (SCI). Its aims are:

- promote the continuous improvement of teaching and the dissemination of chemical sciences at all levels;
- promote the strengthening of research in didactics chemistry encouraging those who are dedicated to this activity both in the university and in the school;
- develop tools to providing public opinion with a correct image of chemistry in modern society.

3. Federchimica. It is the Italian Federation of the chemical industry, founded in 1920. At the present time 1400 companies, with a total of 90.000 employees, are part of the Federation. They are grouped into 17 Associations, articulated into 40 product groups. Federchimica is a member of Confindustria (General Confederation of the Italian Industry) and CEFIC (European Chemical Industry Council). The primary objectives of Federchimica are the coordination and the protection of the role of the Italian chemical industry as well as the promotion of its development capacity.

4. Regione Liguria (Liguria Region). Liguria Region is a Public body with administrative skills and legislative power within the limits established by the Italian constitution.

5. Società Chimica Italiana (Italian Chemistry Society). It is a private organization, based in Rome, composed by chemistry researchers, organized both in thematic divisions and in regional branches, and aiming to promote the knowledge of chemistry. The fundamental objective of the SCI is the dissemination of chemical science and its applications.

6. Ufficio Scolastico Regionale per la Liguria (Regional School Office for Liguria). It is a peripheral organ of the Ministry of Education (M.I.U.R.) at regional level. It is an autonomous center of administrative responsibility and is divided by function and territory in centers of administrative services. It monitors and supports schools and its their reference organ

As it can be evinced, the associated partners were chosen also because of their political role. In fact we cannot ignore that the project, in order to realize efficacious impact on teacher training, also needs to be divulgated by organisms able to reach and influence the Ministry of Education. As mentioned in the paragraph 2.4, the system of teacher education is evolving, but with great difficulty and this evolution cannot be entrusted to the good will of a few persons, but it must be supported and guided in the right direction by an appropriate policy.

4. Conclusions

From the description of the Italian school system, the organization of the teaching of science and the training of teachers, it is clear that:

- Italy provides insufficient training to its science/chemistry teachers
- No gratifications in terms of salary or carrier are foreseen for teachers attending in-service courses
- Chemistry is not considered a fundamental discipline but it is officially a discipline of secondary importance, not worth to be taught separately and by teachers expert of it.

The national situation, so briefly described, widely justify the project and the activities carrying out within it. The most significant activities as regards to improve the training of chemistry teachers were:

- the organization of workshops and not-official meetings between teachers and university researcher
- the supporting work of dissemination done by associated partners
- the work of validation of few ICT resources uploaded on the project portal
- the birth of new collaborations among teachers, not only those involved in the project

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The above activities are even more significant, as the last two were not foreseen by the project but were born spontaneously thanks to the interest and motivation that the project raised in its participants.
In order to make more efficacious the impact of the project at national level it is necessary to dedicate many efforts, during the third and last year, to enlarge the network of people involved or using material uploaded on the portal. In order to reach this objective, the quality of the material dedicated to successful experiences will be fundamental, as well as the dissemination cared by schools and associated partners involved in the project. As above mentioned, the political influence of our associated partners will give a contribute in order to sensitize the government bodies to address more attention to the teaching of chemistry at school and to the training of teachers.

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