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Chemistry is All Around Us

Promotion of Lifelong Learning of Scientific Subjects:

Challenges, Opportunities and Strategies

The Italian National Report

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Italian National Report

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Abstract

In this report we present an overview of scientific lifelong learning in Italy. The national education system is described for what concerns students, as well as adults. The main national trends are represented by three assessments on population literacy, namely the Pisa assessment, published in 2007, (for students), the IALS-SIALS and the ALL assessment, published in 2000 and 2005, respectively (for adults). The somewhat negative results of the cited investigations stimulated the realization of specific projects devoted to improve the teaching of scientific disciplines (ISS project, "Insegnare Scienze Sperimentali") or to face the drop of matriculations to scientific degree courses (PLS project). Moreover, several initiatives have been undertaken in order to improve the spread of scientific culture, such as Science Festivals, TV broadcasts and the publication of some scientific magazines. Remarkable bodies that support scientific lifelong learning are SCI (the Italian Society of Chemistry), the most important organization devoted to popularization and dissemination of chemistry; alternative universities, such as on-line, third age or popular universities. Ten interviews to chemistry teachers and ten to adults have been performed and it has been found out that teachers claim above all the lack of laboratories and of a "hands on" approach as the main reason for students' bad performances and poor interest towards chemistry. Adults often consider chemistry as a difficult discipline where memory is a fundamental tool to learn basic concepts. On this basis, we think that the further development of projects such as ISS and PLS and the introduction of courses devoted to chemistry themes in alternative universities can contribute to the diffusion of a deeper scientific culture.

1. Introduction to the National Situation

1.1 National Education System

The Italian school system is free and divided into five stages: nursery school, primary school, first grade secondary school ("middle school"), second grade secondary school ("high school") and University. It is compulsory up to the obtainment of a diploma or up to 18 years of age.

Nursery school is not compulsory and can be attended by children from 3 to 6 years of age; it is the first education step and also contributes emotional and psycho-motor development.

Primary school is compulsory and lasts 5 years. Attendance and books are free of charge. Compulsory subjects are: Italian, mathematics, a foreign language of the European Union, science, history, geography, social studies, art education, music, physical education, information technology. Religion is an optional subject.

First grade secondary school lasts 3 years and is divided into a first two-year period and in a one-year period; the latter is mainly devoted to educational guidance as to the choice of the high school. Teaching subjects at this level school are: Italian language and literature, mathematics, sciences, two foreign languages of the European Union, history, geography, civic education, technical education, information technology, art education, music, physical education, religion (optional). At the end of the three years an examination must be passed in order to be admitted to a high school.

High schools are divided into two possible educational paths: high school or technical/professional schools. Both give access to University. From the 2010-2011 school year there will be 6 high schools

(classical, scientific, language, artistic, human sciences and musical high school), 2 technical schools (economical and technological technical school, in all further divided into 11 educational paths) and 2 professional schools (service industry and industry, in all further divided into 6 educational paths). The secondary school diploma, obtained by passing a state examination, gives access to higher education: University, art and music higher education or technical higher education.

Attending *University* students can obtain a degree and a specialist degree. The former can be obtained after three years, through the attainment of 180 formative credits and a final examination consisting of the discussion of a dissertation. The specialist degree can be obtained after a further 2 years, through the attainment of 120 formative credits and a final examination. Higher education consists of a Ph.D. lasting 3 or 4 years, devoted to researcher at University or in other research institutions.

1.2 Adult education

For what concerns adults education [1], it is directed towards wide layers of the adult population with the attempt to guarantee all citizens a basic level of competence and knowledge; it is often indicated with the initials **EdA ("educazione degli adulti").**

The first attempts at adult education in Italy began after the Second World War in 1947, when the Country was gripped by the spirit of reconstruction, and the "popular schools" were established with the aim of teaching adults "reading, writing and arithmetic".

In time the target was widened to include, along with workers, also the disadvantaged (prisoners, the disabled, the aged, foreigners, the unemployed, housewives, etc.) as well as those in possession of an educational qualification (diploma or degree) who felt the need for lifelong learning.

In order to cope with the rapid rise in EdA registration during the nineteen-nineties, the institution attempted to regulate the system, establishing certain important points of reference intended to organize the structure and its function.

The first important provision was given by Ministerial order n. 455 of 1997 which established Permanent Territorial Centers, scholastic institutions specifically intended for the provision of adult educational services.

The Unified Conference of 2nd March 2000 added an important contribution to the regulation of EdA sanctioning the agreement between the Government, the Regions, the Provinces, the Communes and Mountain Communities for the reorganization and empowerment of permanent education.

The profound innovations introduced by this document are intended to improve the offer of training which was previously very inhomogeneous and fragmented, characterized by often isolated systems.

The initiatives introduced, in accordance with the European community tendency, aimed at attaining the objectives established by the Lisbon Conference (March 2000), that is the development of a knowledge based society.

In order to reach the desired targets, the various subjects operating in EdA worked together for providing education to all the adult population: firstly for people with insufficient level of literacy and secondly for educated people (high school diploma or degree) needing courses for improvement whether in professional or cultural field.

The educational offer has grown exponentially in the last ten years and can be divided into:

formal learning: This takes place in the education and training centers and provides diplomas and official qualifications;

non formal learning: This takes place out of the main education and training centers and does not usually provides official qualifications. Courses are typically taken in workplaces, young people's

organizations, unions, parties and so on. Courses can also be taken by organizations complementary to formal institutions such as university for older people, agencies and so on;

informal learning: This includes all the cultural activities which can help to improve personal interests and knowledge. A number of public and private subjects boasting a long lasting tradition in providing permanent education is available in Italy:

- Bodies and organizations owning projects admitted to the regional and provincial announcements of competition (Fse permanent education)
- CTPs and high schools where evening classes take place
- People's university, university for older people, leisure and free age university and so on
- Voluntary service organizations, co-operative societies, leisure and cultural organizations
- Female organizations
- Comunal libraries and related schools
- National parks and centres for environmental education

The high complexity and autonomy of the numerous bodies providing courses do not allow a more detailed description of the permanent education system in Italy.

Scientific courses are mostly provided in the workplaces (i.e corsi di aggiornamento) or by the Popular and Third Age Universities; computer science is the most requested scientific discipline whereas others are less so, chemistry in particular.

Most scientific lifelong learning comes from different sources of informal education: festivals, exhibitions, museums, TV shows, magazines, Web sites and portals and so on.

2. Main national trends

In the last fifteen years Italy took part to some international investigations devoted to the assessment of students and adults literacy. The most important are: the Pisa assessment [2], carried out in 2004-2007, with scientific literacy as the main theme (for students); the IALS-SIALS [3], carried out in 1996-2000, and the ALL assessment [4], carried out in 2000-2005 (for adults).

In 2004 the third Program for International Student Assessment **(PISA) 2006** started and the results were published in 2007. It was aimed at evaluating the school performance of 15-year-old students and identifying the features of the school systems of the countries that obtained the best results. Topics of the assessment carried out were scientific literacy, while in 2000 the main subject was lecture and in 2006 mathematics. 400,000 students from 57 countries took part in the evaluation.

The average score obtained by Italian students (475) is quite low and significantly lower than the average score of OECD countries (500); there is no significant difference between males and females. On the contrary, a significant difference could be observed between scores obtained by students from grammar schools (518) and from technical/professional schools (414), as well as between North-eastern (520) and Southern Italy (448). Students from high schools obtained significantly better results than students from technical and professionals schools. A significant difference between schools was recorded in countries that showed low scores, meaning that a strong differentiation in teaching quality among schools does not lead to a generally high standard nor individual excellence.

The most significant investigations on adult literacy were proposed by the Organization for Economic Cooperation and Development (OECD) to its member countries. Italy did not participate in the first investigation, named IALS and conducted in 1994.

The first data collection concerning Italy comes from the **Second International Adult Literacy Survey (IALS-SIALS,** started in 1996 and published in 2000). The literacy of adults (people aged between 16 and 65 years) has been computed for each of the three different domains, prose literacy, document literacy and quantitative literacy, by using 5 evaluation levels. The results were not encouraging: about 30% of adult population was almost illiterate while only 30% showed a medium or good literacy (less than 10% followed a post-secondary school specialization).

LEVELS	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4/5
Prose literacy	**34,6%**	**30,9%**	**26,5%**	**8,0%**
Graphics (document literacy)	**36,5%**	**32,2%**	**25,3%**	**6,0%**
Numeracy (quantitative literacy)	**32,0%**	**31,4%**	**27,6%**	**9,0%**

The results were analogous for each of the three domains. Literacy was seen to be dependent on age and gender, on geographic area of residence and on qualification. Concerning the geographic area, a gap between Northern, Central and Southern Italy was evidenced.

In 1999 OECD proposed a new broader investigation, focused on the evaluation of adults literacy and life skills. With this aim the investigation, named **ALL (Adult Literacy and Life Skills)**, concentrated on the evaluation of scientific competences: adult literacy and life skills were computed for each of the four different domains, prose literacy, document literacy, numeracy and problem solving, by using 5 evaluation levels.

The worrying results, published in 2005, are summarized in the graphic below and do not evidence any improvement in comparison with the results of the previous IALS-SIALS investigation.

LEVELS	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4/5
Prose literacy	**46,1%**	**35,1%**	**16,5%**	**2,3%**
Graphics (document literacy)	**48,8%**	**33,4%**	**15,3%**	**2,4%**
Numeracy (quantitative literacy)	**41,7%**	**41,7%**	**15,9%**	**1,4%**
Problem solving	**69,6%**	**23,3**	**6,5%**	**0.6%**

The ALL survey showed a trend for the decline of the competence as age increases: younger people got the best results, even if, in Italy, people aged in the range 26-35 performed better than people aged in the range 16-25.

The gap between Northern and Southern Italy was confirmed.

Unfortunately, there is not a monitoring system at national level able to measure whether improvements occurred in the scientific competence of the adult population since the start of the ALL survey. The latest available updates date back to 2005 and are published in the annals of the Public Education [1]. The investigation mainly deals with CTPs and high schools where evening classes take place, as they all have common rules and are part of a well-monitored national network.

The monitoring highlights that CTPs (about 540 in 2004) and evening classes contributed to increase to 72.9% the percentage of adults owning a high school diploma. The trend confirms base courses in language and informatics as the most available courses and a strong increase of courses based on social and linguistic integration for foreign people.

The ONEDA (National Observatory for Adult Education) is in charge of monitoring and facilitating lifelong learning but at the moment provides data too fragmented to contribute to the statistics detailed above.

3. Main obstacles to lifelong learning of scientific subjects

In order to identify the main obstacles to lifelong learning in scientific subjects, we have carried out twenty interviews: 10 to teachers (lower and upper secondary schools) and 10 to adults who haven't attended scientific faculties at university. Our aim was not to obtain valuable statistic data, but rather to gather hints for reflection, being aware of the impossibility to get to general conclusions.

Some teachers seem to attribute students' learning problems in chemistry to the intrinsic difficulties of the subject (microscopic dimension, necessity of appealing to 'abstract' models, ...), others to scarcity of equipped labs, many to students' specific lacks (inadequate cognitive requisites, inability of abstracting, lack of interest in studying).

Some teachers (probably not graduated in chemistry) think that also their personal knowledge of chemistry, not sufficiently deep, may contribute to creating obstacles for students. A possible remark could be that the teachers interviewed have never seriously questioned themselves about the points dealt with in our questionnaire, as a deeper consideration of the matter should have made them reconsider their ways of forwarding concepts and information and realize how, very often, they themselves don't really understand what they are trying to communicate.

Maybe the problem lies also in their professional training: among them, only the 'younger' ones (not considering their age but their shorter experience in schools) have attended courses specifically concerning chemistry teaching. None of them seems having heard about research activities or initiatives dealing with 'lifelong learning' of scientific subjects. Some of them report about projects of vocational guidance for students between secondary school and university, though they don't highlight any meaningful relapse.

As far as the adults interviewed are concerned, when requested to tell their personal experiences with chemistry and science, their answers have been 'I was interested in other areas' and/or 'I was not gifted for...'. But at lower secondary school level, it's necessary to work to build and consolidate some basic abilities apart from personal tendencies, in order to educate aware citizens.

Many refer to the role that memory plays in learning chemistry, even a person who 'loved' the subject considering it a 'game': nobody seems to remember their struggle to understand a concept. The result is that everybody consider their knowledge in chemistry poor.

The people interviewed tend to use the Internet to satisfy any scientific curiosities, but without using a critical discernment (they merely rely on search engines, they don't surf specific sites, they at most compare the information from different sites in order to check their reliability). On the other hand, as someone said, you must already have a good level of knowledge to be able to realize a possible low quality of the information found.

Even if they underline some perplexities for the kind of scientific contents offered by the media (they are exploited, they simplify concepts making them banal), the general attitude towards scientific spread and popularization is positive.

The answers to the last questions, aimed at checking whether some basic chemical concepts were or were not acquired and the general attitude towards the subject, show some lacks and misunderstandings and confirm the fact that chemistry is still associated with negative ideas, pollution in particular, as opposed to nature.

4. National bodies in charge of the support of lifelong learning in scientific subjects

National policies and public bodies devoted to lifelong learning of scientific subjects do not exist. The policies of the government have been discussed in the report introduction and consist in the creation and monitoring of CTPs and evening classes that work mainly with the aim of increasing the percentage of adults in possession of a high school diploma and to decrease the percentage of population that risks illiteracy.

For what concerns other bodies, the **Italian Society of Chemistry (SCI)** [5] is the most important organization devoted to popularization, education and dissemination of scientific subjects, with particular focus on chemistry.

SCI is composed of 17 regional sections, 11 divisions (ie. Educational division, organic chemistry, inorganic chemistry..) and many inter-divisional groups. The members are mainly chemists, but the SCI activities are also addressed to schools (from primary to high school) teachers, students and people with basic scientific knowledge, interested in broadening their specific area of knowledge or in satisfying their curiosity about subjects in the field of chemistry. SCI provides a constant update about scientific and technological themes, organizes forums, meetings, courses, schools, collaborates with the Ministry of Public Instruction for the diffusion of scientific knowledge, and edits book and magazines.

The role of the **Division of Chemical Education** [6] is very important as it works hard to improve scientific education at schools and in universities, to encourage people to attend scientific faculties and to increase the level of competence of teachers. The activities of the Italian Society of Chemistry, in particular of its educational Division, show that it is the biggest and the most effective national organization devoted to chemistry teaching and promulgation.

Different kinds of alternative Universities are important bodies in charge of the support of lifelong learning and a careful investigation of their courses has been carried out in order to establish which scientific subjects are considered.

Eleven **on-line Universities** [7] have been instituted and certified by the Ministry of Public Instruction. Few scientific degrees courses can be found by searching the official portal (mainly about engineering and computer science), and degree courses in chemistry are totally absent. Finally, searching among masters and specialization courses, it is possible to find two or three scientific courses concerning alternative energies or criminological and investigative sciences.

Unitre [8] is the national association of the Third Age Universities, aimed to promote the cultural development of the members and to stimulate their activity in social spheres. It forms a network of 268 centers over the whole country that arranges courses and seminars about many different subjects mainly addressed to elderly people. Unitre also takes part in international conferences, seminars and researche to convey the Italian experience and creativity. Also in this case the analysis of the courses carried out evidences that the interest of the members towards scientific subjects is poor. Few courses about topical and debated themes are organized: for example classic and alternative energy, classic and alternative medicine, and food science.

Finally, **Popular Universities** [9] form an important network devoted to adult education. The main objectives of the Popular Universities are in the field of the non-formal education: they offer people the possibility of attending courses about different subjects in order to increase their cultural level or to update their professional knowledge. Courses on foreign languages, literature, art and computer science are the most diffused, while scientific courses earn a fair success when they deal with themes like energy, technology personal care and medicine.

5. National policies implemented to promote lifelong learning of scientific subjects

As a response to the negative results of the past PISA assessments on school performances of Italian students and to the need for a renewal of teaching methodologies, several projects have been undertaken.

The **ISS ("Insegnare Scienze Sperimentali") national project** [10] for example is aimed at teachers of primary and of the first two years of secondary school; it aims to improve the methodological approach in the teaching of scientific disciplines recognizing the centrality of experience and experimentation. The main goal of the initiative is to raise the scientific literacy level of Italian students. To reach this objective, the project intends to i) promote lifelong learning of teachers with the help of territorial facilities; ii) promote didactic autonomy, contributing to the definition of formative standards for scientific disciplines, in order to establish levels of ability to be progressively reached.

The **"Scientific Degrees Project" (PLS)** [10], on the contrary, started in 2005 as an answer to the dramatic drop of matriculation to scientific degree courses (Chemistry, Mathematics, Physics), registered not only in Italy but all over Europe. 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 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 in Italy. In particular, the project intends i) increase the number of matriculates in scientific courses without lowering the teaching standard; ii) increase the number of graduates in 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 for the direct involvement of students in laboratory activities as a tool to increase their scientific knowledge.

The **PON-SeT project** [10], financed by the Italian Government, aimed at the implementation of scientific and technological education in primary and secondary school. The target group of the project are Italian high schools. The project is based on cooperation among several high schools, involving both teachers and students, and on deep dissemination work, aimed at reaching a large number of schools in Italy. The main activities of the project are: creation of websites and portals, organization of online scientific courses, wide diffusion of the materials produced, creation of national and international work-groups, organization of expositions and exhibits, laboratory activities and others.

Every year the **Games of Chemistry** [11] are organized by the Italian Chemistry Society (SCI). This is a national competition organized with the aim of increasing the interest of students toward chemistry and selecting the national team that will take part in the International Olympic Games of Chemistry. The Games of Chemistry are divided in two phases, a regional and a national one.

The regional phase consists of solving 60 problems with multiple answers in 150 minutes.

The national phase is only for the regional winners and consists of solving 60 problems with multiple answers in 150 minutes too. The students with an excellent score in the second phase test are submitted to a further test (questions with open answers) in order to select the components of the Italian Olympic Team. The event has a high impact, as every year about 30.000 students attend the Games.

6. Strategies and initiatives developed at national and local level to promote lifelong learning of scientific subjects

Several strategies have been undertaken too in order to diffuse scientific culture in Italy. Among these, science festivals, TV broadcasts, scientific magazines and museums and so on can be enumerated.

Genoa Science Festival [12] was born in 2003 and is one of the most important events in Italy for scientific dissemination. It is a ten day local event, held in Genoa every year in the month of October. The theme is different every year and is chosen by a scientific committee from among the most topical and discussed subjects. Public and private societies, organizations, cultural groups etc., selected by the scientific committee on the basis of their proposal, carry out the Festival activities. The general aim

of the Festival is making science accessible to anyone by proposing a wide variety of topics as well as a "hands on" approach allowing for the active participation of the public, people of any age including children, students, researchers and experts.

Another example is the **Science Festival held in Rome** (Festival delle Scienze 2009-L'Universo) [13]. This event is carried out annually and consists of a number of events, such as lectures, seminars and concerts aimed at the diffusion of scientific culture. The theme chosen for the fourth edition was "The Universe", as 2009 was the international year of Astronomy and the 400th anniversary of the first of Galileo Galilei's observations by means of telescope. Lectures, seminars and concerts about the theme "The Universe" were held by world-famous physicists, astrophysicists, astronomers, philosophers and astronauts. The goal of this initiative was to give the possibility to as wide an audience as possible of attending seminars and lectures held by world-famous scientists and to make common people more familiar with subjects that constituted one of the most ancient topics of human study.

Superquark [14], for instance, is a broadcast for scientific promotion. It is the most popular program of scientific dissemination in Italy, being the most recent among the wide series of TV broadcasts started in 1981 with the name "Quark" ("Pillole di Quark", "Quark speciale", "Quarkscienza" and finally "Superquark"). Its success is due to the choice of subjects dealt with and to the simplicity of the language used by Piero Angela, the anchorman, and his team .It started in 1995 and goes on the air during the summer once a week with two hours of film reports and documentaries dealing with scientific topics: medicine, biology, chemistry, earth science, physics, technology, archeology, social and cultural problems. During the program several experts are asked about topical subjects in order to clarify doubts and perplexities of common people and viewers.

"La gaia scienza" ("The Gay Science") [15] is a more recent broadcast about science, scientific dissemination and experimentation. It deals with scientific and technological topics in an entertaining way and applies the scientific method to funny or strange problems. It is anchored by a geologist (Mario Tozzi) and three comedians (Trio Medusa). Television viewers can take part directly in the show sending questions and videos of scientific experiments carried out by themselves. The goal of this initiative is to improve scientific dissemination through television and to reach a great number of television viewers arousing in them interest for science.

Focus [16] is a monthly magazine of scientific promulgation. It deals with several scientific subjects concerning human life, scientific and technological progress, nature, history of science. The first pages of the magazine are dedicated to questions and answers between the readers and the Focus experts team. Most of the magazine is divided in sections devoted to the discussion of different themes and made attractive by the inclusion of wonderful pictures. Focus is also published in a version for young readers, named Focus Junior. Also in this case the objective is to increase scientific knowledge, but taking into consideration the age of the readers: they are primary and middle school students. Focus and Focus Junior are also available on line.

Founded in 1953, the **National Museum of Science and Technology "Leonardo da Vinci"** [17] is the largest science and technology museum in Italy. The Museum is housed in Milan in an early 16th century Olivetian monastery and is named after Leonardo da Vinci, the extraordinary Renaissance intellect who mastered art, science and technology. Through the years it has collected and exhibited objects, machinery and evidence that retrace the key phases of Italy's scientific and technological evolution.

Several educational activities are developed in collections and interactive labs to engage visitors in exciting experiences that lead to the discovery and exploration of science.

The museum is structured in seven departments: materials, transport, energy, communication, Leonardo art and science, new frontiers and science for young children. Each department develops studies and research on the collections, plans and offers educational activities, promotes conferences and workshops.

Among scientific museums, **IDIS-Science Center ("Città della Scienza")** [18] is the most innovative hands on museum in Italy, one of the largest and most important European Interactive museums. It is housed in an old chemical factory in Naples, restored by an elegant operation in industrial archeology. It was created by the physicist Victor Silvestrini and occupies 65.000 square meters. Every year new

and topical conferences, seminars, exhibitions and laboratories are conducted in this space. Laboratories are addressed to everybody, but with a particular attention to school students (both compulsory and high school); many laboratories concerning chemistry are available. The IDIS-Science Center is a very important initiative for the dissemination of scientific culture where spreading and teaching of sciences are carried out in order to be accessible to everybody.

Among the initiatives carried out to spread scientific culture in Italy, is also the **Minerva website** [19]. Minerva (www.minerva.unito.it) is a site dedicated to scientific knowledge. It contains about 10.000 pages, that can be consulted with the aid of a search engine. Particular care has been dedicated to 6 sections: history of chemistry and chemical industry, history of experimental sciences, dictionary of chemistry and industrial chemistry, epistemology and ethics, Theatrum Chemicum, periodic system of the elements. A consistent portion of the Minerva site is focused on the scientific and technological knowledge of chemistry. Besides, a great space is devoted to historical and epistemological aspects of experimental sciences. The relationships between ethics and epistemology are discussed in a dedicated section while topics such as 'chemistry and the environment' are treated in order to make science attractive and accessible to all citizens. Theatrum Chemicum is another section that collects a lot of iconographic material because the images of science, including persons and instruments are a fundamental part of scientific knowledge. The site is constantly updated with news from the world of chemistry.

7. Identification of best practices and effective science education initiatives

From the results of the teachers' interviews, it is clear that the most important obstacles to a successful transmission of chemical culture are: a) the lack of a deep chemical culture in the teachers, that are mostly not chemists and have not ever taken part at refresher courses or projects about didactics of chemistry; b) the lack of laboratories in schools.

For what concerns point a) the national project ISS, dedicated to primary and first grade secondary school, and the national project PLS, dedicated to high schools, are very important. Indeed, the teachers involved in the projects have showed a noteworthy improvement of their chemical culture and of their teaching methods. Fortunately, the Ministry of Public Education is going on to fund both the projects so that further improvements in chemistry teaching are expected in the next years.

For the aim of improving the teaching of scientific subjects at school the role of the SSIS schools (Graduate Schools for Secondary School Teachers) has been relevant [20]. SSIS schools have been established by a ministerial decree published in 1998. Their activity started in the 2000/2001 academic year and their function was the training of secondary school teachers; before this time Italy did not demand any other qualification at teachers than graduation. The evaluation of the work ot these schools is very positive but, recently, a reform about the new organization of SSIS schools blocked the start of the last SSIS cycle, the ninth cycle. So many people are waiting to attend the new courses and it will be a real mistake if the Ministry of Public Education decides to suppress these schools.

One of the most impressive results of the interviews performed is the bad reputation of chemistry, that is often considered synonymous of pollution, drugs, toxic substances, and opposite to natural. This false impression could be corrected by the diffusion through the media of a different and more realistic image of chemistry. For this reason, a good practice is the spread of a positive, realistic and, when suitable, amusing image of this discipline through media, such as TV and newspapers.

As another noteworthy result of the interviews is the poorness of the average knowledge of chemistry, a fundamental good practice is the spread of chemical and in general, of scientific culture, through the media and specific initiatives that can reach a large part of population. TV broadcasts such as Superquark or The gay Science, as already described, are very good tools that introduce in an easy, elegant and attractive way also complicated concepts. Their success, that in the case of Superquark has been going on for many years, is a proof of their popularity. Also other initiatives, such as the Genoa Science Festival, are to be numbered among the most useful and successful in the frame of lifelong learning. In this case, a very large number of people (adults, as well as students) have been reached since 2003, as the first edition took place. As described, it is a ten day local event, where

public and private societies, organizations, cultural groups etc., carry out the Festival activities. A "hands on" approach allowing for the active participation of public, made of people of any age, is preferred.

Very important initiatives are also alternative universities, such as UNITRE and the Popular Universities, devoted to increase and enrich the culture of adult people. Their main fault is the lack of a real offer in terms of scientific courses, that are sporadic and dealing with few specific topics. Therefore, the didactic offer of these Universities should be improved by proposing a larger number of scientific courses and making them interesting and attractive also for people that do not own a knowledge of the main scientific disciplines. The courses should be chosen in order to show the relationship between science and daily life and to give people some tools for a better consciousness of the world they belong to.

In general, it can be concluded that many good initiatives have been and currently are carried out to increase the scientific culture of adults, but they are mostly sporadic and not organized in a network of strategies centrally coordinated.

8. Conclusions and strategy proposal

From the assessments performed in the last years, on students as well as on adults, the population average scientific literacy level turned out to be quite low; from the interviews carried out, moreover, several teachers cited their not deep knowledge of chemistry as a possible obstacle for their students (many chemistry teachers have not in fact any degree in chemistry). Basing on these data, we think that efforts for a better diffusion of scientific culture should be addressed mainly towards two groups of people, i.e. adults and teachers.

For what concerns adults, many initiatives have been undertaken, as previously described. Several of them obtain a great success and are characterized by a high scientific level. Nevertheless, we think that a central coordination of all these initiatives is still lacking. Moreover, although numerous institutions support the scientific education of adults (on-line, popular, third age universities, for example), still few courses with chemistry as the main theme are organized, so keeping alive the prejudice of chemistry as a “difficult” or a “mnemonic” discipline. Many more courses dealing with scientific subjects should be activated and, for what concerning chemistry, they should be taught by expert persons able to a) make attractive and interesting this discipline, b) show people that chemistry is all around us and 3) demonstrate that everybody can understand it.

For what concerns teachers, on the contrary, a great effort has been made in the last years thanks to the institution and realization of some projects, such as ISS (“Insegnare Scienze Sperimentali), PLS (Scientific Degrees Project) or PON-SeT. Though some of the interviewed teachers assert not to having heard about this kind of activity, many of them have attended courses specifically concerning chemistry teaching. The maintenance and the further development of such initiatives can contribute to create a new generation of more competent and aware chemistry teachers.

Finally, as previously observed, many people do not know most of the initiatives devoted to lifelong learning of scientific subjects. Therefore, the careful organization of a new efficient network for the dissemination of the whole didactic offer is essential to the success of the proposed strategy.

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