Promotion of Lifelong Learning of Scientific Subjects

Challenges, Opportunities and Strategies

Transnational Report

Education and Culture DG

Lifelong Learning Programme

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Transnational Report

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Context

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

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

To address this situation, the Chemistry Is All Around Us project intends to identify the existing successful strategies for the promotion of Life Long Learning in scientific issues and spread them through the potential of ICT, in order to provide a method and related educational tools, that can provide learners, starting from the school level, with the knowledge and the skills to be able to informally learn about science throughout their life.

Among the scientific fields, Chemistry is identified as an exemplary Case Study as it is recognised as one of the most problematic subject. That is because, Chemistry suffers from a growing unpopularity due to the fact that the media often makes improper connections between Chemistry and the ideas of pollution, health threats, manipulation of natural structures etc.

The Chemistry Is All Around Us Project intends to promote a comparison between the strategies implemented in the 6 countries involved (i.e. Bulgaria, The Czech Republic, Germany, Greece , Italy, and Turkey) for the promotion and diffusion of a more aware and interesting approach to Chemistry (chosen as exemplary case studies for scientific subjects) at all levels of the Educational and training Systems, in order to develop an internet portal, to collect, share and experiment with the best practices in the field.

1. Introduction to the National Situations

1.1 Bulgaria

1.1.1 National education system

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

By the level of education offered

- Grade schools: education is carried out in two stages (primary and elementary) and respectively :

  Primary stage involves – primary schools /I-IV grade/; elementary schools /I-VIII grade/; secondary comprehensive schools /I-XII grade/; schools of arts and special purpose schools.

  Elementary stage involves – grade schools /V-VIII grade/; secondary comprehensive schools /I-XII grade/; schools of arts, vocational schools; sports schools; special schools.

- Secondary schools: secondary education is carried out in high schools, profiled high schools /VIII-XII grade/, vocational schools, special schools and schools of arts.

By the content of training

- Comprehensive schools.

- Vocational schools.

- Special schools.

Training is carried out at the above type of schools. Vocational colleges are also included in this list as they offer training after secondary school graduation.

The tertiary education system comprises 51 institutes of higher learning including 42 universities and specialized institutes, and 9 individual colleges. Following a minimum of a 4-year course of instruction the graduates acquire the educational and qualification degree of Bakalavar (Bachelor's degree). Training for each specialty is finalized by sitting for state examinations or presentation of a diploma thesis.

1.1.2 Adult education

Bulgaria has a long-standing tradition of organizing continuous training within the higher education system. A variety of educational forms has been offered to those wishing to continue their education, with accredited units for ongoing, continuous and post-graduate training operating at almost all higher education institutions.
Adult education is carried out in the following forms:
- Formal education and /or training: is carried out within the structure of the educational system or at Vocational Training Centres. It leads to the acquisition of a degree of education and /or degree of professional qualification.

- Informal training: is, as with formal education, target oriented and organized (courses, private lessons, workshops, on site training) and does not lead to acquisition of a degree in education or professional qualification.
- Individual training: purpose oriented learning activity aimed at raising the level of personal knowledge and skills (training is effected with the assistance of a family member, a colleague or

friend; through the use of printed materials such as course books, computerized study courses, TV educational programs, audio/video CDs etc.)

Structures, which provide opportunities for acquisition of new personal professional knowledge and skills, are termed Centres of vocational training (CVT).

There are a number of other suppliers and those who assign training from the state-owned, the private and the non governmental sector:

- Adult education and continuing professional training offered by vocational schools and high schools.

- Adult education offered by evening upper secondary schools. They are the major form leading to a secondary school diploma for those who work and adults above 16 who have dropped out of schools.

- Adult training offered by tertiary education institutions. Attended by people holding a secondary education diploma who want to get a tertiary degree and people holding a tertiary degree seeking a master's or re-qualification degree or taking part in short-term courses and specializations for developing of existing skills.

- Adult education and continuing professional training offered by the Bulgarian-German Centres for Vocational Training.

- Adult training offered or assigned by the National Employment Agency and the Labour Bureau departments (LBD).

- Adult training and continuing professional training assigned by enterprises.

- Adult training and continuing professional training offered and assigned by the social partners.

- Adult training offered by private suppliers including non-government organizations (NGOs).

- 'Znanie' network (an association for circulation of knowledge) – it is the biggest Bulgarian NGO that offers adult training and supports suppliers of adult training through institutional building and development of human resources.

In the Private sector there are the following centers: 'Veda consult', Gabrovo – an adult training centre; Training Centre at the Novotel, Plovdiv (training for waiters, barmen and similar vocations from the sphere of tourism); 'Danchovata kashta' Resto center in Plovdiv (a centre for continuing professional training in crafts) and many others [1,2,3,4,5].

Learning in situ (in the work place) is implemented through various forms in Bulgarian companies. Informal education and training is the most important of the various forms of learning in the work place. Participation of Bulgarian employees in informal education is a result of their personal initiative.

1.2 Czech Republic

1.2.1 National education system

Schools in the Czech Republic are divided according to the level of education and the nature of education provided into: kindergartens, elementary schools, secondary schools, conservatories, higher vocational schools (colleges), elementary art schools, language schools authorized to organize state language examination and the universities.

Educational policy and the state and development of the education system are the responsibility of the Ministry of Education, Youth and Sports (MEYS).

Regarding universities, a Higher Education Act passed in 1990 restored autonomy and academic freedom in higher education and, by reducing state interference to a minimum, provided universities with a high degree of independence. Due to the rapid developments in the tertiary sphere, a new Act was passed in 1998. It brought an important change in the establishment structure and majority of institutions became public institutions with increased autonomy. It also became possible to establish private institutions.

In the beginning of the 21st century, the Czech education system focuses on the following aims:

- equal opportunity in education

- curricular reform

- support of foreign languages and information and communication technologies

- development and implementation of quality assurance systems, methods of evaluation and self-evaluation of schools

- increasing professionalism and improving the working conditions of educational staff

- support of continuing education

1.2.2 Adult education

Further education and training is provided by schools of all levels, by employers, public administration and self-governing bodies and by their educational institutions, by non-governmental non-profit organisations including professional and commercial organisations.

Because of the extensive network of schools, the geographical accessibility of further education provided by schools is relatively good, however easier in and around big cities, more difficult in the country.

Majority of courses organised by employers are most often in economics and accountancy, languages, information and communication technologies and their utilisation and in various technical branches, or in marketing.

Adult education teachers usually do not receive any special training. However, topics relevant to adult education are included in in-service training. There are three university departments training experts in adult education (mostly human resource management):

- Faculty of Philosophy of Charles University in Prague – The Department of Adult Education and Personnel Management.

- Faculty of Philosophy of Palacky University in Olomouc – The Department of Sociology and Adult Education and Department of Special Education with a field special adult education.

- Jan Amos Komensky University Prague

The relatively low level of participation of citizens of the Czech Republic in further education in comparison with EU countries is a consequence of a high level of participation in secondary education. Nevertheless, increasing participation is necessary due to the dynamic technological and social development which results in the need to change existing qualifications and broaden them with information and communication technologies and knowledge of languages.

In 2007, the Ministry of Education, Youth and Sports adopted the document ‘The Strategy of Lifelong Learning (SLL) in the Czech Republic. Its intention is to gradually establish achievable targets that can be promoted, also by resources from European funds in the 2007 – 2013 programming period. The strategy is based on an analysis of the basic strategic documents of

the CR and the EU (and is in full accord with these documents), which are related to or directly concerned with the aspects of lifelong learning from various points of view. The SLL says that the process of lifelong learning cannot be centrally managed and all the key participants at the level of government, regions, enterprises and individuals must support lifelong learning as the decisive factor in the competitiveness of the country. The creation of the motivating legal and economic environment that allows funds to be invested effectively is a precondition for the development of lifelong learning

1.3 Germany

1.3.1 National education system

There is no uniform education policy. Education and culture is focused on the 'Länder', the states of the federal organised Germany. So there are as many different education laws as there are federal states, differing sometimes slightly, sometimes profoundly from each other.

Germany has a three-tier school system:

1. 'Hauptschule' : general-education secondary school, level 1, yrs 5-9.

2. 'Realschule' : intermediate school, level 2, yrs 5-10.

3. 'Gymnasium': secondary school, level 3, yrs. 4-12.

and the 'Berufsschule' : vocational school, yrs.9-12.

The graduation of each school provides access to a certain kind of further training. After completion of the secondary school it is possible to study at a university without further training or graduation. After the completion of the intermediate school it is possible to study at a university of applied sciences and after the completion of this study a transition to the university is possible. After the completion of the general education secondary school the students usually attend the vocational school to complete a vocational training.

There are possibilities of transition under certain conditions at some points even for the students of the general secondary school.

1.3.2 Adult education

Adult education in Germany can start after graduation of the general - education secondary school, level 1. Adult education and VET is organized in the tertiary or the quaternary sector for further training or Life Long Learning offers.

As Germany has a three tiered education system the access to higher education is dependent on the level of graduation you have achieved, so if you want to have a University degree or a degree of a University of Applied Sciences, you have to do further training. A lot of institutions do provide training programmes for this goal. Some of them are private; some of them are public providers.

This system continues for the training of additional vocational skills or for training for the job (e. g. to make a career) or re-training.
The problems are obvious: training is an economically interesting market and is highly competitive. Quality, accessibility, time, money and proximity are very sought after, resulting in the offer of distance learning which can lead to dubious offers with unreliable service.

1.4 Greece

1.4.1 National education system

It is comprised of three levels: Primary, Secondary and Tertiary Education Levels.

Pre-primary (nipiagogeio) and Primary School (dimotiko scholeio) form the Primary Education Level covering the ages between 4-12 years (not compulsory for 4-year olds).

Secondary Education is divided in two parts:

- Lower Secondary School (Gymnasio), a compulsory 3-year part of studies.

- The Upper Secondary School: provides the options of either General and Vocational Upper Secondary Schools (Geniko kai Epagelmatiko Lykeio) or Vocational Education Training Schools (EPA.S.). Duration of studies in the latter cases is 3 years (or 4 in the case of Evening General and Vocational Schools).

Finally, the Higher Education Level includes Universities (Panepistimia-AEI), Technological Education Institutes (Technologika Ekpaideftika Idrymata-TEI) and The School of Fine Arts (ASKT).

Vocational Training Institutes (IEK) are not assigned to any of the previously mentioned educational levels. However, the training provided is considered Formal and they are considered to belong to the category of Post-compulsory Secondary Education.
Education is compulsory between the ages of 5-15 years old, namely including Pre-primary Education, Primary Education and Lower Secondary Education. Progression from the Compulsory Secondary Education to the Upper Secondary Level is based on the overall passing grade (daily work, written tests, assignments and end-of-year written review examinations) at the end of the third year of Lower Secondary Level. A school-leaving certificate from the Upper Secondary Education Level is a prerequisite for the admission to Higher Education. Admission to the Tertiary Education Institutes is determined by the general achievement score which takes into account the final year school grades and the graduates' results in six general education and 'stream' subjects in annual National Level Examinations (Panhellenic Exams). University Tertiary Education is a State-only provided jurisdiction.
Graduates from Tertiary Education Institutes are awarded the first cycle degree (Ptychion) which leads either to employment or to continuation of studies in a higher level such as Master's (Metaptychiako Diploma Eidikefsis) or Doctorate degree (Didaktoriko Diploma).

1.4.2 Adult education

Teaching of scientific subjects in Adult Education can be summarized as follows:
Vocational Training Institutes (IEK) provide vocational training, whether initial or supplementary, in order to ensure the acquisition of relevant qualifications for the trainees through the provision of scientific, technical, vocational and practical knowledge, and to facilitate the acquisition of socially and professionally useful skills so as to ensure their graduates' professional integration and their adaptation to the ever-changing needs of the labour market. According to the Organisation for Vocational Education and Training (OEEK), in 2007 there were in total 114 public and 53 private IEK. They regularly offer Vocational & Educational Training Courses in subjects strongly related to Chemistry involving a wide selection of Chemistry subjects. In particular, streams which offer Chemistry oriented vocational courses are 'Chemical Industries', 'Food & Beverage', 'Energy & Environment', and 'Applied Arts'.
Adults who have not completed compulsory education can follow Second Chance Schools (SDE) and be granted a qualification equivalent to the one obtained by Lower Secondary Education after successfully following a two-year duration Programme. Administratively, SDE come under the General Secretariat of Lifelong Learning (GSLLL) and in particular under the Institute of Adult Lifelong Education (IDEKE) structure.

Second Chance Schools also involve Chemistry as part of the Science courses in the curriculum of studies. The course is taught for 2 hours per week. They also offer Mathematics on a 3-hour weekly basis and Environmental Studies courses for 2 hours per week. [6]
Centers for Adult Education (KEE) apart from 'Mathematics and Basic Statistics', offer several Educational Programmes related with the Environment and Sustainable Development. Many of the courses are Chemistry-related (Atmospheric Pollution, Indoor Air Pollution, Water Resources, Water Pollution, Urban Solid Waste, Waste Management, Waste water Treatment, The Ozone Layer, Acid Rain, Greenhouse Effect, etc.). The duration of these programmes spans between 25 to 50 hours. [7]

The Center of Distance Education for Lifelong Adult Learning (ΚΕΔΒΜΑΡ/ΚΕΔΒΜΑΠ) provides a distance programme in Environmental and Sustainable Development. As in the case of KEE (see above) similar Chemistry-related courses are involved in the structure of the Programme which lasts 250 hours and is provided on an annual basis starting in October for a period of about 40 weeks . [8]

The Hellenic Open University is considered part of LLL since admission to the courses is open to all Upper Secondary Level graduates regardless of achievement scores. Selection is based on a random computer-based procedure. As a concept it belongs to both categories of Tertiary Education and Lifelong Learning (LLL). Degree holders have equal rights to typical Tertiary Education graduates. Studies offered include an Undergraduate Course in Natural Sciences and Postgraduate Courses in 'Catalysis and Environmental Protection', 'Teaching Natural Sciences', 'Waste Management' and 'Advanced Studies in Physics'.

1.5 Italy

1.5.1 National education system

In Italy the school system is free and compulsory up to the attainment of a diploma or up to 18 years of age. It is divided into five stages: nursery school, primary school, first grade secondary school ("middle school"), second grade secondary school ("high school") and University:
- Nursery school: is not compulsory and can be attended by children from 3 to 6 years of age.
- Primary school: is compulsory and lasts 5 years.
- 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 high school. At the end of the three years an examination must be passed in order to be admitted to 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.
- University. Attending University students can obtain a degree and a specialist degree. The former can be obtained after three years, while the specialist degree can be obtained after a further 2 years.

1.5.2 Adult education

It is often indicated with the initials EdA ("educazione degli adulti"). 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 of 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)
- Permanent Territorial Centers (CTPs) and high schools where evening classes take place. They were instituted by a Ministerial order in 1997 and are scholastic institutions specifically intended for the provision of adult educational services. CTPs and evening classes 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.
- 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.
- Communal 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.

1.6 Turkey

1.6.1 National education system

According to the Basic Law on National Education the fundamental principles of Turkish national education are 'universality and equality', 'individual and social needs', 'orientation', 'right to education', 'equality of opportunity', 'continuity in education', 'Atatürk's Reforms and Principles and Atatürk's Nationalism', 'education for democracy', 'secularism', 'scientific approach to education', 'planned education', 'coeducation', 'school – parent cooperation' and 'education everywhere'.

The Turkish education system comprises pre-primary, compulsory primary, secondary and higher education levels. Pre-primary education is a non-compulsory education stage covering education of children between 3 and 6 years. All pre-primary education institutions are under the supervision of the Ministry of National Education.

Compulsory primary education is delivered in single structure primary school and it lasts eight years, between ages of 6 and 14.

Upper secondary education is provided in general, vocational and technical education institutions (named as *lise*) offering at least four years of education for those who have completed single structure primary education. There is a variety of general and vocational schools.

Higher education consists of universities, higher technology institutes and independent private (foundation) vocational higher schools. Except the very few independent private (foundation) vocational higher schools, higher education institutions are gathered under the frame work of university (or higher technology institute).

1.6.2 Adult education

Adult education in Turkey is mostly carried out by public non-formal education institutions. Education/training institutions and their activities for the young and the adults can be classified in the following:

Adult Education Centers (AEC): Adult education activities organized outside the formal education in Turkey are mostly carried out in AECs. Within these centres, literacy courses, vocational courses, social cultural courses and applications for individuals at any age and any education level are organized. AECs can also organize courses in cooperation with private and public institutions. Besides, public institutions, municipalities, foundations, associations and vocational organizations can organize courses free of charge under the control of the Ministry of National Education.

Vocational Education Centers are the institutions which provide apprenticeships, headmanships and mastership education and short term vocational courses for those who did not or cannot attend an upper level education or are out of formal education for some reason. They are open to all primary education graduates at any age group. It is aimed at developing semi-professionals needed in industry.

Adults Technical Education Centers are non-formal industrial technical education institutions constituted for the aim of enabling youths with at least primary education to acquire vocations, develop the vocational knowledge, skills and instruction in new technologies for industry. Boarding facilities are provided in these centers.

Practical Art Schools for Girls are non-formal vocational and technical education institutions providing vocational education through various duration and level modular programs for girls and women who finished formal education institutions, left at any level of formal education or never enter this system.

Tourism Training Centers are non-formal education institutions implementing 30-week duration "tourism enterprises personnel development basic training courses" programs to develop skills such as cooking (cook) pastry-cook, barmen, services, flat servants, clerical services needed in the tourism sector in the area of Food and Drink Services, Housing and Travel Services. Students attend a four-month skills training program in these institutions.

1.7 Comparison among countries

1.7.1 National education system

The education systems of the countries participating in the project are basically similar in the organization of the education levels, but different according to the history of the single country and to the ideas that inspired the development of the school system.

The education system, in terms of level of education, is divided in primary (or elementary) school and secondary school. As mentioned above the National Reports describe very similar organizations and little differences are related to a further subdivision of the secondary school. Moreover, secondary schools can be divided in terms of educational contents and two main categories can be identified: the first one provides a preparation suitable for pursuing studies at university, while a second category provides professional studies.

The education system of the six countries is mainly entrusted to a central government, apart from Germany that has a different system. Indeed German policy is not uniform because education and culture is focused on the 'Länder', the states of the federal organised Germany, while the central government has a secondary role.

In all countries education is compulsory for children between 5-6 and 14-16 years old.

1.7.2 Adult education

Adult education consists mostly of courses for people that need to acquire a degree of education or a degree of professional qualification and courses for people in possession of a secondary diploma or degree that wish to enrich their knowledge in different topics or get continuing professional training.

Part of the education supply is controlled by the national governments and part by enterprises, private centers and agencies, non-profit associations and similar. It is possible to monitor activities and results only when courses are carried out by state bodies, while the other numerous private centers are often autonomous and, therefore, out of control, especially for what concerns teacher competence.

Concerning Greece the situation seems to be less confusing and more organized. Indeed adult education is mostly focused on the work of centres and institutes belonging to networks with a common regulation, such as 'Second Chance' Schools and Vocational Training Institutes.

Also Turkey describes a more simple and uniform system for adult education as the courses are mostly carried out by public education institutions.

2. Main national trends

2.1 Bulgaria

Education and training for adults is not common practice in Bulgaria. A survey conducted in 2005 by Eurostat among the labor force of EU countries indicates that Bulgaria is the poorest performer with a mere 1.3% of its employees and civil servants being involved in training programs during the last four weeks prior to the survey.

However, despite these findings, the National Statistical Institute has conducted a series of surveys related to the level of participation of adults, aged 25-64 , in one of the forms for lifelong learning. Reported figures vary from 16% for 2003 to 48.5% for 2007.

A close analysis of the survey outcomes indicates that:

- Over one third (36.4%) of the population from the 25-64 age group were involved in at least one form of formal and , more frequently, informal training by the end of 2007. There is an insignificantly small difference in the percentage of participation of men (37%) and women (35.0%). Another interesting observation was that only 19.7% of those who had participated in some type of formal or informal training declared their willingness to take part in other similar activities. The remainder 80.3% expressed their unwillingness to continue their participation in other types of related learning activities.

- Individual training covered 28.0% of the population from those aged 25-64. Women seem to be more active with 29.7% compared to men whose share is 26.2%.

- Persons from younger age groups, e.g. 25-34, are considerably more active in formal and informal education or training with 44.7% as compared to 39.7% for the age group 35-54 and 20.3% for the age group 55-64.

- Every third person, that is 35.2% of the population in the age group 25-64, has participated in at least one informal training exercise. For 96.3% of the participants their informal training was closely related to their work and for 89.5% their informal training was conducted mostly during their work time.

- Most active participants in learning activities are found among university degree holders, 71.1% of which have participated in some form of education or training during the 12 months prior to the survey. Every second person with a university degree i.e. 50.0% from the population of the 25-64 age group has participated in some form of informal training for a period of 12 months. This percentage is comparatively lower, 38.2%, for secondary school graduates or holders of first level professional qualifications; it is lowest (15.0%) for persons with primary and lower education. Differences in percentage outcomes are much more considerable for the representatives of the three levels of education in terms of their involvement in individual learning which is 54.9%, 24.6% and 10.1% respectively.

- Employed persons participate in various forms of Lifelong learning more actively compared to those regarding themselves as unemployed and those who are economically inactive.

- Almost ¾ of all participants in informal training have taken part in one form of training for a period of 12 months prior to their interview ; every fifth participant - 19.7% has been involved in two training exercises ; 3.1% have participated in three trainings and 2.4% have covered four or more trainings.

- Places of residence also affect involvement in lifelong learning as urban residents share in this process is 52.2% as compared to the percentage of those living in the country (38.0%). City and town residents are more active and have a wider range of possibilities for participation in informal training as compared to those living in the country.

The outcomes of this survey are indicative of a prevalent attitude among those in active work age 25-64 to get involved in formal or informal education or training only at the necessary level and for the period of survey, were unwilling to continue their participation in other similar activities of learning.

2.2 Czech Republic

Regarding the Czech Republic, in the Implementation Plan to the Strategy of Lifelong Learning, adopted in 2008, the Ministry of Education, Youth and Sports analyzed the current situation in the country and one of its features was low interest of students to continue studies of technical and natural science and low interest in careers in this area. This situation is partly explained by the general attitude of the society that has so far preferred careers in law, economy and management as more prestigious and prospective. However, it must be admitted that this situation is also caused by the way these subject are taught at schools, where the emphasis on passive knowledge prevails over a modern scientific approach and students are not motivated enough to continue in further studies. Implementation Plan suggests to take measures to improve this situation in the cooperation of regions, communities and social partners, financed on a grant bases from European funds (namely European Social Fund) within the framework of Operational Programme Education for Competitiveness. [9]

2.3 Germany

The education system in Germany has been deeply influenced in the last years by the disastrous results of the first OECD study (Pisa). As a consequence, Germany started a nation wide educational initiative to enhance and change the educational system and structures to facilitate Lifelong Learning strategies. In this study German pupils had under average results in all of the tested categories. In the category “Natural Sciences” German pupils got range 20 (out of 31). The reasons for these results were identified as old fashioned teaching methods.

One of the results that showed the need of fundamental changes in the German educational system was that education in Germany is still a privilege. Access to higher education is still focused on higher social status. One of the weakest points of this system is the insufficient integration of children out of socially underprivileged families and Migrant children.

The German „Kultusministerkonferenz“ draw the consequences out of the results, starting in 2001.

This body decided for 7 “Fields of action”

1. Measures for enhancing language competencies, starting in the Kindergarten

2. Measures for a more sufficient interlocking of pre-school and primary school focused on an early school start

3. Measures to enhance education in primary schools, especially facilitating reading competencies and the comprehension of Mathematics and Natural sciences

4. Measures to promote children of educationally deprived families and migrant children

5. Measures to develop systematically the quality of teaching at school and a continuously evaluation

6. Measures to promote professional teaching especially methodological competencies

7. Measure for a systematic facilitation of all-day schools and off-schools incentives to promote pupils in need of more support.

2.4 Greece

The latest general trends concerning Lifelong Learning in Europe according to Eurostat (10/06/2010) in Greece showed that less than one third of Greece's population (17.4%) was involved in any kind of learning, formal, non-formal or informal. (Formal education corresponds to education and training in the regular system of schools, universities and colleges, non-formal education and training includes all types of taught learning activities which are not part of a formal education program, and informal learning corresponds to self-learning which is not part of either formal or informal education and training, by using different methods like books, computers, learning centres or educational broadcasting). The percentages ranged from 27.2% at the 25-34 years old group age to 7.2% at the 55-64 years old group age with men slightly more active in learning activities (18.3% males – 16.3% females). In respect with non-formal learning participation rates were generally low (4.9%), and showed very large differences with age (9.2% at the 25-34 years old group age to 1% at the 55-64 years old group age) educational levels (high educational level 13%, medium 5%, low 1%) and working status (employed 6.1%, unemployed 6.9%, inactive 1.6%). Non-formal education intensity is higher among the unemployed and inactive population (108 and 113 hours per participant correspondingly) giving a total average of 85 hours per year regardless of sex or occupation.

As far as statistical data on Natural Sciences or Chemistry alone are concerned, these were absent from the set of data concerning the field of learning, possibly because no Science-dedicated programs and courses were carried out. [10, 11]

2.5 Italy

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 [12]. The latest available updates date back to 2005 and are published in the annals of the Public Education [13]. 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 of 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.

Till now, only 6,2% of adults participate in training activities (European average: 9,9%) but, in accordance with the 2010 Lisbon strategy, we should achieve that at least the12,5% of 25 - 64 years old will be engaged in training.

2.6 Turkey

PISA 2006 study, with its wide geographic and co-operative structure, includes 30 OECD member countries with 27 non-OECD member countries. PISA 2006 study was held in May of 2006. The study covers natural and applied sciences, mathematics and reading skills; and, in this study, natural and applied sciences were concentrated. Turkey participated in PISA 2006 with a total number of randomly selected 4942 pupils in 160 schools, who were classified according to the regions and their schools, from 7 geographical regions and 51 cities.

According to the PISA 2006 report, Turkey's science average is 424 points. There isn't any significant difference between science literacy average points of Bulgaria, Uruguay, Jordan, Thailand, Romania and Turkey. In addition Turkey has performed better than Montenegro, Mexico, Indonesia, Argentina and Brazil. According to PISA 2006 competency levels, students in Turkey have the following competencies in the science field: they only have sufficient scientific knowledge to draw a conclusion based on simple research, and they can make possible explanations in ordinary situations. They can make logical inferences and simple interpretations according to the results of scientific interrogation or technological problem solving.

2.7 Comparison among countries

On the basis of results of surveys like OCSE-PISA and ALL, that show a low level of adult literacy for all the countries participating in the present project, the respective governments worked to strengthen life long learning by creating centres and institutes dedicated to this aim.

Despite the supply of numerous different courses devoted to adult education, the National Reports evidence that too many people are not interested in improving their knowledge, in particular scientific knowledge. Statistics reported by Partners show different numbers but they all evidence the same problem: adults attend LLL courses only when it is really necessary, which means when they need a diploma or when they want to reach a higher professional qualification, not because they wish to improve their education.

In order to face this crisis of interest some countries, in particular Germany and Turkey, paid special care to improve the education system and methodology of both primary and secondary school. The expected result is to train young adults, more cultured and curious enough to continuously learn during their life.

3. Main obstacles to lifelong learning of scientific subjects (chemistry in particular)

The analysis of the main obstacles to lifelong learning of scientific subjects has been mainly carried out the basis of the answers to the twenty interviews with teachers and adults that were part of WP2 (case studies). Moreover some countries supported the results of the case studies with a selection of national papers dealing with the obstacles to teaching-learning of scientific concepts.

3.1 Bulgaria

Modern school education in Bulgaria is directed towards the abilities of the average student - it helps all graduates to acquire solid skills for reading, writing, speaking, practical skills for managing and making decisions. Nevertheless, over the last few years some negative tendencies could be faced. Many students quit the educational system without enough training. A considerable number of them do not continue their education to a higher level and those who remain in the system do not acquire the necessary skills and competences, and do not meet the requirements of employers. An alarming long standing tendency towards deterioration of the literacy level is observed.

A survey conducted in Bulgaria among adult trainees indicates that there are two main reasons for giving up the option of university studies after secondary school graduation:

- Financial: no financial possibility to pay for university tuition; this forces young people to start work and, consequently limits their options for formal education. In that case the only possibility for training is in the form of informal and individual learning.

- Lack of appropriate orientation concerning the preferred university or degree course. This leads to inadequate preparation, hence the poor performance at admission exams and the inevitable failure to enroll in the courses of study at the selected university.

As a part of the fundamental education chemistry learning in Bulgarian schools starts in the primary school and continues in the secondary for a period of 2 - 3 years depending on the profile of the school. According to learners some of the most frequently faced difficulties in chemistry studies at school are connected with:

- the content of course books which is difficult to comprehend;
- poor methods of teaching and inadequate and biased assessment of knowledge;
- outdated, inadequate or unavailable laboratory equipment which does not allow for the conducting of experiments and does not contribute to better comprehension of the taught subject.

These factors make up an overall understanding among school students that chemistry is an unintelligible and sophisticated science.

Most of the interviewed secondary school chemistry teachers share similar opinions concerning difficulties in the acquisition chemistry teaching material:

- academic style of course book content which is difficult to understand for students - this is true for both grade and high schools. Knowledge should be grounded on and oriented to practical experience;

- depreciated material base and insufficient modern equipment – the lack of proper equipment is one of the most serious problems related to the study of chemistry;

- no willingness and motivation to study;

- lack of specialized literature written in easy to comprehend language for students who learn chemistry;

- not enough training courses for teachers related to the interactive methods of teaching chemistry.

- young people are poorly motivated for learning chemistry after secondary school. Interest in learning chemistry has been plummeting for a long time and is rooted in the changes in society, organization of the learning process and the method of teaching this discipline in primary and secondary schools.

1)the formulated notion that chemistry is a “difficult” and “dangerous” science - most of the students perceive chemistry as a complicated and incomprehensible science. This opinion is expressed both by learners and secondary school teachers. The above mentioned is a direct result of the following reasons: disorderly and unclear content of course books; poor teaching - progress check and assessment were on a very low level; outdated, inadequate or unavailable laboratory equipment which does not allow for conducting experiments; large classes, impossible division into subgroups;

2)no prospects for professional realization - chemistry is deemed inapplicable in opting for professions;

3)destroyed public system of values - long years of the continuous disinterestedness of the state in the matters of education and culture.

4)

3.2 Czech Republic

From the interviews it has been found that there are many problems with teaching chemistry at secondary schools as well as at years 8 and 9 of primary schools. From the Interviews with teachers it is clear that it is a problem; we have to look into many aspects and try to find proper solutions that will lead into improvement in teaching technical and natural science subjects.

<u>„Bad“ teachers</u>

Why do we have bad quality teachers? They are tired, without interest and disillusioned. Their classes are too big, their wages low and they are not only teaching chemistry, but also concentrating on problems with student behaviour. Chemistry is usually the least popular subject among students.

Some chemistry university graduates want to start teaching chemistry but this career change is quite difficult. They have to study again, at least a three year bachelor degree in pedagogy and that usually puts them off. We are lacking faster pedagogy course for these people. It would be quite suitable as they usually have great chemistry knowledge, but young families cannot afford to spend so much time on studies.

<u>Lack of requisites and equipment</u>

The situation differs a lot in secondary schools. Strictly speaking, it is not the biggest problem, but still, there are some schools that are incredibly behind with basic requisites. Some governing bodies do not provide funds for lab equipment, study handbooks, requisites etc. It was very discouraging when during the interview, we met teacher from secondary school specialized in natural sciences, with 10 chemistry lessons per class per week, but with almost no labs and very “ancient” requisites. We assume it would be desirable if there is some kind of check and control from the Ministry of Education, that would at least guarantee some standard level of equipment and requisites. Parents and students should have some kind of quality assurance. It is also true that head teachers and teachers can apply for grants to improve school’s equipment but to be honest, even without this activity teachers are almost exhausted and overloaded. They simply do not have the capacity for additional activities.

There would be the possibility to connect schools to local businesses and factories, to scientific institutes etc. Schools could maybe regularly use their labs, students could see the application of science in everyday life. This is very rare in the Czech Republic. These days students have no idea about the application of chemistry in real life, do not know the careers in chemistry and science, they even often do not know their parents jobs!

Lack of motivation

The word „motivation“ in capital letters probably constitutes the “key to success”. We have to show students careers in chemistry, introduce them to successful scientists, show the jobs in industry. We were proudly turning the society into services only to see that now there is nobody able to produce drugs, clean water and environment, food and much more, based on chemistry.

Students are motivated by the prospect of lucrative careers and we have to show them, that there ARE such careers in chemistry. At the moment they only know chemistry as a boring subject with a lot of theory and memorizing - without understanding what this is good for!

„Difficult subject”

Difficult, not interesting topics. Lack of time for interesting experiments. Topics with no sign of practical use. Chemistry is also very complex and students have to understand it from the beginning, one topic is based on the previous one so it is necessary to have good teachers all the time and to get student attention all the time.

First year at secondary schools seems to be crucial and very difficult. There are enormous differences in the students’ knowledge of the subject. The ones with excellent teachers at the primary school have to slow down now as the teachers are very busy helping students from primaries with poor knowledge of chemistry. It can sometimes put off the good ones as well as the bad ones and it is all up to the teacher what the result will be. We would suggest that the students really interested in chemistry should attend some courses at the university already at the secondary school age, some “chemistry – student – incubator”. There they could meet similarly oriented peers, professors, use the labs - as the secondary school teachers usually do not have time and equipment for this.

Another problem is the secondary schools system. We have so called gymnasium (grammar school), usually generally oriented secondary schools. These can be 8, 6 or 4 years long. Often the 8 and 6 years long have good, talented students, while the 4-years long usually have students who were not successful to enter the 8 or 6 years long schools. This means that the quality of these schools is lower. Some of the historically very good natural-sciences oriented secondary schools are only 4 years long and their quality is declining as is declining the quality of students.

3.3 Germany

The main obstacles to LLL in Germany are:

- lack of motivation

- insufficient consultancy and advice

- insufficient involvement in scientific orientated vocational training

The case studies that were done in a further training course for “Nutrition Consulter” (all the participants were women) support the above statements. The women were not really interested about the topic: “this is dull”, “I don’t know anything about chemistry”, “I am not interested in that matter”, “I can’t see the context to nutrition” etc.

Even if a participant was interested in the subject at the beginning of her school or training career, she lost that interest after a while, often because she could not see a professional future in that field or because there was too much mathematics, or because the teacher wasn't able to motivate her.

The results of a small chemistry test within the case study were underwhelming. In combination with the comments the women gave, their reluctant behaviour and disappointing results seem to be the consequence of a motivational problem or a problem of attitudes or both that started in the beginning of their school careers.

3.4 Greece

For what concerns the Greek situation, the barriers to lifelong learning in scientific subjects can be attributed to three main reasons, supported by several papers:

- the nature of chemistry

- the student's difficulties

- the student's attitudes

The National Report of Greece contains a noteworthy selection and discussion of papers dealing with the obstacles to chemistry learning and teaching. Therefore we suggest a careful reading of the latter in order to get a complete discussion about this topic.

The case studies were conducted by interviewing 10 adults (6 men – 4 women) in a wide age range (23 to 58 years old). All 10 adults had some tertiary education degree in a subject which was not related to science. The questions posed to the adults aimed at identifying factors that cause barriers to lifelong learning of scientific subjects, with emphasis on Chemistry (Why did you decide not to continue your studies in some scientific subject, what difficulties did you face in the Chemistry course in secondary school, what do you think of the word "chemical".

The analysis of the case studies gave rise to the following results regarding the barriers to lifelong learning:
a) Teaching methodology. Chemistry is often taught very theoretically, with no lab work (or only via demonstration experiments) and with no reference to its connection with everyday life phenomena. Emphasis is given on learning many things by heart and on problem solving.
b) Inadequacy of the chemistry teacher. Teachers fail to create a positive atmosphere and stimulate students' curiosity for learning and enthusiasm.
c) Too difficult textbook, with very difficult language.
d) Very demanding and heavy content of chemistry curriculum.
e) Intrinsic difficulty of chemistry concepts, necessity for a certain level of logical thinking and lack of basic knowledge, discourage students from further study. Fear of problem solving
f) Very little allocated teaching time per week (1 hour per week).
The barriers to lifelong learning identified via the case studies analysis are similar to the ones identified from research and presented in the literature review. It is noted that most barriers brought about from the case studies are related with the ones concerning "students' attitudes" and were briefly reviewed before. Research on the factors that influence attitudes towards chemistry should be given increased importance.

3.5 Italy

Twenty interviews have been carried out: 10 with teachers (lower and upper secondary schools) and 10 with adults who haven't attended scientific faculties at university. The 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 (not graduated in chemistry) think that also their personal knowledge of chemistry is not sufficiently deep and this 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 seem to have 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 the 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.

3.6 Turkey

The results of research done at national level with regard to science teaching, including especially chemistry teaching, have been examined and evidence the following obstacles:

- evidence of several student's misconceptions

- students' knowledge about basic symbols and units is insufficient

- insufficiency of laboratory activities and laboratory equipments

- inadequacy of teaching methodology

As a result of the analysis of the case studies, it is easily understood that the most important barrier to the lifelong learning of scientific subjects is teacher-centred education methodology.

Most of the participants indicated that they learned scientific concepts, especially chemistry, on a theoretical basis. They said that they only memorized the concepts and problems about chemistry and after their formal education, they easily forgot what they learned.

After their formal education, people do not continue to learn or study scientific concepts, because the education given has no connection with everyday use of those concepts. Insufficient laboratory equipment causes a lack of practical experiments and this also reduces the connection between the concepts and everyday life.

Teacher-centred nature of educational environments reduces the motivation to learn and investigate scientific concepts. Very heavy curriculum in contrast to few weekly hours of chemistry lesson also makes it difficult to learn the subjects.

Finally, adult learners complaint about the insufficient materials, programs or any courses for the lifelong learning of scientific subjects after formal education. They say that they cannot find any opportunity to learn about them.

3.7 Comparison among countries

Interviews with teachers and adult learners, besides some reviewed papers, show the disastrous relationship between students and chemistry. This subject is unpopular also among adult people that associate chemistry to negative concepts such as pollution, anti-natural, poison and do not wish to improve their really poor, and often incorrect, knowledge.

More specifically, partners describe very similar obstacles to lifelong learning of chemistry, that are the following:

- Chemistry has a bad image. Chemistry is associated with negative aspects of life and is considered as the antithesis of what is natural.
- Chemistry is considered a difficult subject because it makes use of difficult language, microscopic and macroscopic level at the same time, mnemonic concepts, models and seems to be abstract.
- Chemistry teachers are not adequate. Many of them are not graduated in chemistry and most of them did not attend a specific training necessary to ‘learn to teach’ .
- Text book are too difficult.
- Laboratory activities are absent or, in the best cases, sporadic or inadequate.
- There is a lack of motivation. Students and adults think that chemistry is an abstract subject and do not manage to see its connection with everyday life. Moreover they do not know at all the job opportunities of a chemist.

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

4.1 Bulgaria

These are the national bodies involved in LLL in **Bulgaria**:

At national level:

- *Ministry of education, youth and science (MEYS) and its General directorate " structural funds and international educational programs"* – one of the main programs is the Operational Program "Human Resources Development" - The strategic goal of the Operational Program is to improve the quality of life of people in Bulgaria through enhancement of the human capital, achievement of high employment levels, improvement of productivity, access to high-quality education and lifelong learning and strengthening social inclusion; the directorate has a well-developed frame of regional coordinators in all over the country.
- *Ministry of labor and social policy (MLSP)* – in co-operation with MEYS the ministry is responsible for activities under the Operational Program "Human Resources Development"; the regulation body at national level is General directorate "European funds, international programs and projects;
- *National Agency for Vocational Education and Training* - specialized body to the Council of Ministers of the Republic of Bulgaria established in 2000. Its mission is:

  - Assuring and maintaining quality in the vocational education and training of young people and adults according to the labor market needs and the development of the Bulgarian economy competitiveness;

  - Cooperation with social partners in implementing coordinated policies for lifelong learning, continuing vocational training and introducing successful European practices;

  - Expanding the access of the unemployed and the employed to vocational education and training according to the labor market needs;

  - Ensuring public access to useful information concerning the continuing vocational training and lifelong learning in the country and in the EU.

  - Development of the List of professions for vocational education and training

  - Development of State Educational Requirements (standards) for acquiring qualifications

- *Bulgarian National Agency of the Community Vocational Training Action Program "Leonardo da Vinci".*

At the regional level:

- *Regional Inspectorates of Education* – there are 28 regional structures of MEYS, which support and control secondary schools activities.
- *"Veda consult", Gabrovo* – an adult training centre.
- *Vocational training centre – Technical University of Gabrovo* – it is an authorized centre for adult education.

4.2 Czech Republic

The main responsible body in the area of life long education is the Ministry of Education, Youth and Sports. The competence of the Ministry of Education in further education is stipulated by the Act on Verification and Recognition of Further Education Outcomes issued in 2006. The Act aims to increase motivation for further education and enables to certificate not only full qualifications but even so called partial qualifications, i.e., competences necessary for carrying out partial activities within an occupation. The Ministry of Education coordinates activities performed by central administrative authorities under the Act. Retraining is intended mainly for the unemployed and is controlled by the Ministry of Labour and Social Affairs through Labour Offices. This may be provided only by educational institutions with study programs accredited by the MEYS. The education of employees of enterprises and organizations is managed by the enterprises themselves. There is a wide range of commercial lifelong learning courses, which is not subject to state control.

Since the 1990s, continuing education, adult education, lifelong education and human resources development therefore have become subject of many strategic documents and projects which prepare measures for their successive implementation. The first one was the National Program for the Development of Education in the Czech Republic (White Paper) that put emphasis on legal framework for the development of adult education, financial and non-financial aspects of the development of lifelong learning and systematic development of adult education.

Further legal document on lifelong learning – Education Act adopted in 2004, in force since January 2005 recognizes the possibility of learning through life as one of principles of education; it also introduces new instruments with the aim of improving the accessibility of the education system. Provisions on lifelong learning are also included in the Higher Education Act under which schools can organize long life education including professionally oriented or special interest programs, e.g. universities of the third age. Conditions of long life education courses are specified by internal rules of individual institutions (for example fees that are usually charged for these courses). In accordance with Higher Education Act, participants in life long education are not seen by students as such.

We do not assume that the above mentioned overview of legal acts concerning long life education is complete, nevertheless we perceive the legal framework for life long learning sufficient. It is also necessary to mention that due to its membership in the EU, the CR´s legal framework is in compliance with the EU documents in the area.

4.3 Germany

The strategies to support and promote Life Long Learning must be seen in context with a fundamental national report of the German government. This report followed the first World Summit on Sustainable Development; WSSD, 2002 in Johannesburg.

The national report is the framework for sustainable development during the period 2002 – 2005.

After 2005 this was followed by the start of the UN world decade 2005 – 2014 for “Education for sustainable development”, leading in Germany to new “Guidelines for Sustainability” which were released by the Bundeskabinett in 2005.

In 2008 the German Government released the “Conception for Lifelong Learning” in order to improve the situation in this area.

For the German Government Lifelong learning is one of the biggest political and societal challenges facing Germany and one of the priority tasks of education policy.

This development is due to the shock of the first OECD study: “PISA” in 2000.This study showed the disastrous state of the German educational system in comparison to its European and international partner countries.

The results induced a chain reaction and a profound and systematical change in education policy.

In the named “Conception for Lifelong Learning” the aims reflect the results of the study. After a decrease of participation in continuing education to 43% in 2007 (all 19 to 64-year-olds) and in general and vocational continuing education (same group) to 27% the aim of the education policy in Germany is to increase the participation in Lifelong Learning programs to 80% till the year 2015 (in the group of the 25-64 year olds).

The participation in formal vocational educational trainings shall be increased to 50% and for people with lesser qualifications from 28% - 40%.

In an OECD study (Education at a glance, 2008) Germany is attested to have an under average participation in continuing educational programmes and a special deficit concerning the participation of formal lesser qualified people.

4.4 Greece

In Greece the established institutional framework concerning Lifelong Learning (LLL) is supported by a number of agencies and organizations. Lifelong Learning provision has mainly been devolved to the agency of the General Secretariat for Lifelong Learning (GSLLL) [14], which evolved (2008) from the previous General Secretariat for Adult Education as an advanced agency supervised by the Education Ministry and entrusted with the design and implementation of a broader spectrum of LLL – mostly informal learning – platforms with a wider impact and equitable accessibility along with its complementary executive agency, the Institute for the Continuous Education of Adults (IDEKE) .

The educational structures which are under the auspices of GSLLL/IDEKE and carry out LLL programs are the following : Second Chance Schools (SDE/ΣΔΕ), Centers for Adult Education (KEE), Schools for Parents, The Center of Distance Education for Lifelong Adult Learning (KEDBMAP/ΚΕΔΒΜΑΠ), Prefectural Committees for Adult Education (NELE/ΝΕΛΕ) and Vocational Training Centers (KEK).

Additionally, actions towards LLL are hosted by the Hellenic Open University, the Greek Manpower Employment Organization (OAED), the Organization for Vocational Education and Training (OEEK), and the Central Union of Municipalities and Communities of Greece (KEDKE).

4.5 Italy

National policies and public bodies devoted to lifelong learning of scientific subjects do not exist. The policies of the Ministry of Education, consist of 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.

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 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 is the national association of the Third Age Universities, aims 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 researches 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 form an important network devoted to adult education. The main objectives of the Popular Universities are in the field of 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.

Concerning other bodies, the Italian Society of Chemistry (SCI) 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 (i.e. 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.

The role of the Division of Chemical Education 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.

4.6 Turkey

The notion of lifelong learning in Turkish education system means; internalizing an approach which accepts the individual as the center of education, giving importance to education out of the schools, changing the role of the schools and decreasing the role of the state in terms of education by increasing the role of social initiatives. One of the aims of the lifelong education in Turkish National Education system is; providing formal education to the citizens who never got a formal education or is at a certain level of formal education in accordance with the general aims and basic principles of National Education.

The Basic Law of National Education (No: 1739), passed in 1973 determines the Ministry of National Education to be responsible in determining and developing all formal and non-formal education policies. So the Ministry of National Education is responsible of providing support for lifelong learning to the individuals with its various formal and non-formal education bodies, supporting other education programs provided by other Ministries or half-formal and volunteer institutions, and ensuring coordination at local and national level between these education programs.

For the integration of lifelong learning into the education system, the Ministry of National Education makes new arrangements in the aims and programs of the school system and gives importance to out-of school learning opportunities. By doing this, it aims to change the focus of education from formal education to continuing education. Two phases are accepted for this aim,

first is motivating individuals in formal education to continue their learning after school, and the second is educating adults according to their needs.

All lifelong learning activities organized out of formal education institutions are mainly conducted in the Adult Education Centers. These centers realize non-formal education activities by means of literacy courses, vocational courses and social-cultural courses. Besides these, there are distance education institutions that have further education for the persons who did not have the advantage of formal education at the required ages.

In addition to the Ministry of National Education the other ministries also have their own lifelong learning programs (e.g. health care, house economics, education of citizenship, etc…) in their own fields of study. These services generally fail to be effective as the need for such services increase rapidly.

4.7 Comparison among countries

The Governments of the partner countries are really interested in implementing life long learning and entrust this task to their Ministry of Education.

The Ministry of Education acts by establishing Centers and Agencies aimed to improve life long learning and by coordinating their several activities. Annually, it provides or modifies the National Program for life long learning and funds national and regional projects.

Unfortunately, no one of the National Reports mention a specific care toward scientific subjects: the efforts of Ministry of Education are devoted to improve adult education in all the disciplines.

In addition to Ministry of Education, few other bodies are responsible for improving life long learning: for example, Turkey names ministries of health care, house economics, education of citizenships, while Bulgaria has the Ministry of Labour and Social Policy and the National Agency for Vocational Education and Training.

Moreover the role of alternative universities, such as Hellenic Open University (Greece) or Unitre (Italy) has to be mentioned.

Finally, Italy praises the work of the Italian Society of Chemistry (SCI), the national association really devoted to popularization, and dissemination of scientific subjects, with particular focus on chemistry.

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

5.1 Bulgaria

National policy about lifelong learning is based on following strategies at national level:

- National strategy for lifelong learning (LLL) for the period 2008 – 2013 [20.

The National Strategy worked out by Bulgarian Ministry of education, youth and science includes a conceptual framework for lifelong learning.

The aim of the strategy is to create conditions for all citizens in Bulgaria to develop their personal and professional knowledge, skills and capabilities, and improve their own welfare and the competitiveness of national economy through:

1) increasing the adaptability of economic and social changes;

2) encouraging participation in all forms of lifelong learning for professional and personal development.

- National strategy for continuing vocational training (2005 – 2010)

A National Strategy for Continuing Professional Training (2005- 2010) has been developed by the Ministry of Education, Youth and Science, Ministry of Labour and Social Policy, the Ministry of Economy, the Ministry of Finance, the National Agency for Vocational Education and Training, the Bulgarian Chamber of Commerce and Industry, the Bulgarian Industrial Association, and the Confederation of Independent Trade Unions in Bulgaria.
Depending on the needs of society and of the individual person, the specific objectives of adult education are related to giving a 'second chance' to people who have prematurely dropped out of the education system, facilitating the access to the job market by acquiring qualifications in those professions for which there are available positions for employment and demand for specialists, supporting the professional realization of the unemployed.

Structures, which provide opportunities for acquisition of new personal professional knowledge and skills, are termed Centres of vocational training (CVT). A network of centres of vocational training has been built which supplements the possibilities for training offered by the system of public education. There are a number of other suppliers and those who assign training from the state-owned, the private and the nongovernmental sector:

- National Program for Development of Education, Science and youth policies in Bulgaria for the next 4 years

The program, presented by the Ministry of Education, Youth and Sports aims:

- Achieving high quality of education.
- Ensuring equal access to education and opening up the education system.
- Development of conditions for implementation of the educational concepts "LIFELONG LEARNING".
- Incentives young people in the development and implementation of sector policies.

- Conversion of Bulgaria in the medium term to a country in which knowledge and innovation are the drivers of the economy.

- *Annual National Contests in scientific subjects (including chemistry)*

The contests are targeted at students from all secondary schools in Bulgaria and aim at verifying the quality of education in scientific subjects. The contests build links between secondary schools in Bulgaria. They also allow the assessment of students' knowledge placed in a different environment from the day to day. Competition creates a strong link between knowledge and its application. It also allows for comparison between different training schools and is a natural place for the exchange of new approaches to training students in scientific subjects (chemistry and environmental protection also).

Bulgarian Ministry of labour and social policy proposes financing of projects and activities according to a few schemes, enhancing the education system or promoting and encouraging LLL, in scientific subjects also. The most important of these schemes, related to education and LLL are: *Making the school more attractive for young people, I can etc.*

5.2 Czech Republic

The government of the Czech Republic promotes in its education documents and activities lifelong learning in a general way – it does not usually deal specifically with particular subjects. Therefore, it is the responsibility of the Ministry of Education as the main responsible body in the area of education at all levels to promote lifelong learning in scientific subjects.

Due to the low level of interest of young people and general public in scientific subjects, the project *Support for Technology and Science Fields* [21] started in the beginning of 2009 (until 2011) and is co-funded by the Ministry of Education and by the European Social Fund. It is aimed at introducing a system of marketing support for technology and science fields of study at universities and other institutions of higher learning. Project activities are divided into three major pillars: motivation activities, science communication and teaching support, and they are both directly and indirectly aimed at the target group of potential applicants for study. The project is to provide among other things a methodology of support for technology and science education, background marketing materials, analysis and case studies to be presented by way of conferences, seminars, workshops, popularization lectures, and particularly by way of pilot motivation activities in all regions.

5.3 Germany

For the German Government Lifelong learning is one of the biggest political and societal challenges facing Germany and one of the priority tasks of education policy.
With this aim the Federal Ministry of Education and Research initiated and strongly supports numerous kinds of facilitation and promotion for scientifically and technically based continuing vocational training programmes or studies.
A big effort is focused on schools, primary as well as secondary ones. Good practice examples show their specific concern, e.g.:
- early contact with regional companies and networks
- internships
- facilitating learning modules for pupils in need of special support
- individualised, tailor-made modules
- consultancy, advisory and matching of pupils and companies
- gender sensitive approach

Moreover, to keep up with these aims the Federal Ministry of Education and Research launched:
- action programmes, including schools and municipalities as well

- learn-feasts at schools or in regional networks
- days of… e.g. Chemistry, Girls-day
- years of... e.g. Chemistry year in 2003
- MINT initiatives (Maths, Information-technology,Natural sciences, Technicalfields)
- Technicum. (The Technicum is a sort of internship with a mentoring system. Pupils after their final secondary school examinations
- National contract for women in MINT Jobs
- competitions/prizes for young researchers and special issues,
- special programs for young people e.g. : Maths –Olympic games
- special programs for excellence
- conferences on every level from local to national
workshops and seminars.

5.4 Greece

In alignment with the Lisbon Strategy a reform project has started seeking to overhaul the whole Greek Educational System. The reform procedure started from LLL and Higher Education.

The establishment of an adequate institutional framework and a functional LLL network, devolving the General Secretariat of LLL as the central body for LLL provision, has simplified the administrative planning tackling fragmentation and dispersal of LLL services and agencies. Investments in the field and functional improvements have reversed the situation concerning LLL in the country in the last years, making achievable the target of participation of 12.5% of the population in LLL programs by the end of 2010.

The particulate actions that materialize the state LLL policy can be distinguished into two complementary categories: the general programs that are carried out by the General Secretariat for LLL itself and the ones implemented by the agency supervised by the Secretariat, the Institute for the Continuous Education of Adults (IDEKE/ΙΔΕΚΕ). Apart from Second Chance Schools the remaining structures (Adult Education Centres, Parents Schools, Lifelong Learning Prefectural Committees, Vocational Training Centre, Centre of Distance Lifelong Education and Training for Adults as well as the autonomous programs of the General Secretariat for Adult Education) belong to informal education for adults.

More specifically, as far as LLL of scientific subject is concerned, we have already referred to the teaching of scientific subjects in adult education (see section 1.4.2 of this report). In addition, the major national strategies and initiatives for promoting LLL of scientific subjects, which obviously fall under the umbrella of “policies”, will be presented analytically in Section 6.4 of the current report.

5.5 Italy

The policy of the Italian Government to improve lifelong learning does not show specific care toward scientific disciplines. The actions of this policy are mainly devoted to the support of CTPs, that work to raise the level of literacy of population, and to improve the school system.

In order to increase the learning of scientific disciplines, the Ministry of Public Education is working to improving the teaching of the latter at school. For this aim, guidelines for national projects involving both teachers and students are published annually.

Namely, three national projects, aimed at implementing the learning of scientific subject in schools and universities, are financed by Italian Government:

1) the *ISS (‘Insegnare Scienze Sperimentali’) project* [22] 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.

2) The '*Scientific Degrees Project' (PLS)* [22], started in 2005 as an answer to the dramatic drop of matriculation in scientific degree courses (Chemistry, Mathematics, Physics and Science of Materials). 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 idea driving the project is the need for the direct involvement of students in laboratory activities as a tool to increase their scientific knowledge, in collaboration with their teachers.

3) The *PON-SeT project* [22] 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.

Finally, for what concerns chemistry, it is worth mentioning that, every year, the Italian Society of Chemistry (SCI) organizes the *Games of Chemistry* [23], a national competition aimed at increasing the interest of students toward chemistry and at selecting the national team that will take part in the International Olympic Games of Chemistry.

On the contrary, the recent reform of high school has reduced the hours of science teaching, in particular of chemistry, giving real problems to the employment of chemist teachers.

5.6 Turkey

Turkey's insufficiency has been proved by international achievement evaluations, The Ministry of National Education has made significant changes in the science curriculum of primary schools. The name of "science curriculum" has been replaced by "science and technology curriculum".

In the preparation of the curricula, various countries' science curricula have been examined and Turkey's regions' geographical and physical infrastructure and facilities have been considered. Weekly hours of science and technology lesson have been increased to 4 from 3. The curriculum of science and technology lesson, has been aimed "to make all students science and technology literate whatever their individual differences are". It is suggested that science and technology literate individuals will be more effective in reaching and using information, solving problems and producing new information.

Ministry of National Education have been undertaking "Quality Control and Case Study" research at both national and international levels aiming at evaluating the education capacity since 1992. For this objective the Ministry of National Education participates in research like "Students' Achievement Determination Examination (SADE)" at national level, and Program for International Student Assessment (PISA), Trends in International Mathematics and Science Study (TIMMS) and Progress in International Reading Literacy Study (PIRLS) at international level. In this research, standard achievement tests and student, teacher and school inventories are applied. Data from these tests and inventories are used to identify students' acquisition degree of some basic skills and to identify the current situation of education system.

5.7 Comparison among countries

The policy to promote lifelong learning is similar for the different countries. Its main objectives are focused on giving a 'second chance' to people who have prematurely dropped out of the education system and on facilitating the access to the job market by the acquisition of suitable qualifications.

The specific field of scientific disciplines, a well defined and continuing policy is not evident from the examination of the National Reports. Indeed the actions are often fragmented and limited to a few years and the lack of a long-term common strategy can be evidenced.

The most important actions are addressed mainly to secondary schools and consist of activities to monitor the education system and to improve the methodology of teaching. They aim to attract students to scientific disciplines by stimulating their curiosity and making more accessible the teaching-learning process.

The establishment of a new and more adequate education system for scientific disciplines is expected to be the fundamental step to build a continuity between school and permanent education.

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

Strategies and initiatives listed below are the result of a careful selection, therefore only those that are considered really effective by each partner are presented.

6.1 Bulgaria

The National Contest in chemistry and environmental protection is an annual competition of high school students. It aims at verifying the quality of education in chemistry and the environment in all schools in Bulgaria. The Contest is targeted at students from all secondary schools in the Republic of Bulgaria. The competition creates a strong link between knowledge and its application. It also allows for comparison between different training schools and is a natural place for the exchange of new approaches to training students in chemistry and environmental protection.

Agreement for cooperation between the social partners in the chemical industry. The agreement aims at cooperation between manufacturers, unions and workers in the chemical industry in Bulgaria. It's emphasis is long-term measures for training and qualification of workers in the sector. The initiative builds relationships and conducts training at national level in the Chemistry sector. Agreement was made between employers, trade unions and workers, which governs the general problems of Chemical industry.

Continuing education for teachers in Bulgaria, is a project linked to the dissemination of the concept of continuing education for teachers of all subjects (including Chemistry) in the whole structure of Bulgarian education. It aims to develop a strategy for continual education of teachers, to prepare materials and to create prerequisites for its elaboration.

Virtual Chemical Laboratory project creates a virtual laboratory in chemistry intended for students, teachers and adults who want to consolidate their basic knowledge of chemistry. This project enables everyone to learn the basics of chemistry without any supervision required on behalf of a qualified teacher. But it can also be used by teachers who want to diversify their way of teaching.

Virtual Chemical Laboratory 'Himix' is another regional project. 'Himix' is a virtual laboratory for e-learning in chemistry. It provides opportunities for simulating chemical reactions, access to a large amount of information related to chemistry and unlimited opportunities for renewal.

Chemistry on the stage (scientific theatre) is an interesting approach for increasing the interest towards the natural sciences and basically chemistry. It has been chosen in the National Aprilov High School - Gabrovo. It is realized through an original education – theatrical performance, the so called 'scientific theatre'. Three such performances have been prepared and performed during the last four years. The participation of the students in the different stages is voluntary and of their own initiative, while the teachers are only coordinators.

Different Schools, Common Problems is a project aimed to improve the quality of education and raise student's achievement by analysis of the school syllabus in the different partner schools and countries, student's attitudes towards the school subjects included in the survey /English Language, Mathematics, Biology and Chemistry/, finding successful study habits, examining teaching methodology, exchange of best practices. Different actors are involved in the project work – teachers, students from 5th to the 10th grade, experts, colleagues from other schools, willing to give professional comment on the video recorded classes, parents, local communities.

Mosaic of Science and Culture is a project that investigates the connection between natural phenomena, science and culture. It tracks out the evolution of science and culture and the work from antiquity up to present, investigates and observes the natural phenomena, taking place at different geographical positions.

Water and water mills, past and present. One of the purposes of this project is to encourage the acceptance of the water mills as an alternative source for ecological energy. During the first stage analysis of drinking water was made and the consumption of the water reserve with the aid of questionnaires and calculations.

Under the sector program *LEONARDO DA VINCI* 21 projects have been realized. The most important of them are:

- *Classical and alternative sources of energy*, aimed at acquiring the European technological achievements and to apply them in the vocational education. Students had the opportunity to work with a device which produces energy through sun collectors and wind installations. Students prepared reports with comparative analyses including the similarities and the differences between the French and Bulgarian power stations.

- *Project of University 'P. Hilendarski' Plovdiv town* . Methodology of chemistry education increases the quality of the modern education in chemistry and the professional preparation of the students who will become teachers in chemistry in future. The stress falls on the development of approaches, methods and organizational forms, assisting the specific skills in chemistry and the skills for LLL [24].

6.2 Czech Republic

Scientia Pragensis - Day of Science at Prague Universities is a one day exhibition and seminars of Prague universities on research in their respective fields (not only technical and natural science). The main objective is to attract secondary school students and the public to show them interesting results of research done at the universities.

Gaudeamus – European Education and Lifelong Learning Exhibition is an annual exhibition accompanied by lectures and presentations where the Czech, European and other international institutions offer the most study opportunities for students from central Europe. Gaudeamus offers a wide range of business, technology, language, computer and communication studies and therefore provides a good overview of educational possibilities in the Czech Republic. It focuses on secondary school graduates, college and university students, young graduates and executives as well as adults who wish to improve their knowledge or redirect their career.

Lessons of Modern Chemistry are organized by students and academic staff from Institute of Chemical Technology in Prague in secondary schools across the Czech Republic. Lessons are interactive, based on dialogue between participants and are full of experiments (the idea now is to extend the offer with 3D projections in biochemistry) with the intention of bringing a new and modern view of chemistry to students, make it more popular, present trends in modern chemistry and practical applications of chemistry in our everyday lives.

Summer School of Modern Chemistry is a nationwide traditional event organized by the Institute of Chemical Technology as a 3 day workshop for secondary school teachers of chemistry, biology and biochemistry. The objective of the initiative is to promote and support the idea of LLL among teachers, keep them informed about current state of affairs in research, motivate possible future students of scientific subjects and show them the reality of research and its social impact. Summer school includes lectures and experimental work in labs.

Following two projects – *ECHO and EURO* – both deal with educative materials for teaching chemistry and both are co-financed from European sources under the ESF. The main goal of *ECHO (Electronic Support for Chemistry Teaching)* is to modernize the teaching of chemistry in three chemical disciplines (inorganic, organic and analytical chemistry) via new support materials. The quality of teaching of chemistry is the core of project *EURO (Effective Learning through the Reforming of the Secondary Education)*, a regional initiative of 9 secondary schools where each has chosen its field of expertise and prepared modern and innovative teaching materials to share with other schools.

The project *ChemPoint* (co-financed by the ESF) wants to establish a contact point that would facilitate communication between researchers and the application area in the field of chemistry; it deals with specific and specialized area of research – industry cooperation on the national level.

The project *Czech Head* exists since 2002 and represents several interconnected activities and initiatives with the objective to support research and technology development in the Czech Republic with the aim to make research and science more popular and enhance the prestige of scientists and researchers within society. Top event is a Czech Head Award for best individuals of research and technology

The project *Open Science* concentrates on secondary school students interested in science; it offers about 150 of them the possibility to participate at scientific internships in the laboratories and research centres of the Academy of Sciences and cooperating universities.

6.3 Germany

The Federal Ministry of Education and Research supports initiatives to facilitate the decisions of people to participate in vocational and continuing vocational training programs to get a job in the chemical/technical sector.

This is shared and promoted by the *Society of German Chemists*. This society promotes chemistry teaching in Germany in primary as well as in secondary schools.

One of the initiatives is a fund, another one the web-site: *Chemistry4you* (with a profiling test as a vocational preparation) and the initiative: *Educational strategy Chemistry* with a consortium of the social partners and stakeholders in this sector.

Moreover, there are some good initiatives, described below, to support the decisions of students and pupils to go for a chemical or technical discipline

Blue Genes is a kit which enables high school teachers to perform basic experiments of gene analysis and cloning at school. With the equipment and the reagents provided in the kit the class can perform a restriction analysis, cloning, and expression experiments of a bacterial gene.

Experimentierkasten Kuno is another kit that has been developed for children of classes 2-4 in primary schools. Properties and applications of plastics are presented in a non-fiction book for children. Experiments can be carried out by children by themselves.

Experimentierkasten Tini und Toni has been created for children of classes 2-6 in primary schools. Simple chemical experiments are presented in a booklet for children The experiments can be carried out by children by themselves.

Weekend seminars and congresses for chemistry teachers are organised by the regional associations of the VCI (The German alliance of the chemical industry).

A '*Newsletter' for chemistry teachers* is published three times a year. The newsletter contains information from the chemical industry and other sources.

Schulpartnerschaft Chemie is a brochure for chemistry teachers. It contains best practice examples from the school promotion programme.

Kuchen, Flirt und Nanowelten is another brochure, which shows the important role of chemistry in our everyday life. Examples: health, textiles, energy, communication

Chemie im Fokus is a website for career opportunities and information about the study of chemistry This site is a joint activity between VCI and the German association of chemists.

Mentoring-projects have the financial support of partnerships between schools and institutions, such as chemistry departments of universities or chemical firms, for their establishment of e.g. permanent labs for pupils, science camps and other co-operations or activities intended to give children/pupils a realistic picture of the various job outlines in Chemistry and the requirements necessary for these jobs.

International Olympics in Chemistry, is a competition under the financial support of the 2004 Chemistry Contest, in which especially talented pupils of schools for general-education solve scientific problems, investigate independently and develop new ideas.

Informationsserien are transparency series dealing with special topics of interest out of sectors, such as chemistry, environment, biotechnology, etc. The folios can be ordered free of charge by teachers/schools.

Finally, it is worth mentioning that, following the aims of the Federal Ministry of Education and Research, Berlin has presented a *Masterplan Qualification* underlining the given topics and strategies shown above.

6.4 Greece

Greece organizes several initiatives devoted to improve the quality of scientific teaching.

Chemistry Departments of some Greek Universities (Athens, Ioannina) have included in their undergraduate programs elective courses in Education and Methodology of Teaching Chemistry [25].

The Chemistry Departments of three Greek Universities (Athens, Thessaloniki and Ioannina) and the Department of Chemical Engineering of the National Technical University of Athens are co-organizing an interdepartmental program of graduate studies leading to the *acquisition of a Masters degree, entitled: Chemical Education and New Educational Technologies*. The program aims at providing scientific and educational training at graduate level to already serving and prospective high school chemistry teachers in Greece. All newly appointed chemistry teachers at the secondary education public system attend an obligatory training course in teaching methodologies organized by the National Ministry of Education Lifelong Learning and Religious Affairs.

Moreover, the *Association of Greek Chemists* organizes every year a *two-day seminar* on secondary chemical education aimed at providing educational training to active secondary school chemistry teachers in Greece.

The role of *museums* in science education has been noted by several researchers and references are made in the report. More specifically, the initiatives undertaken by four museum structures (two large (1and 2 below) and two smaller ones (3 and 4 below)) deserve to be mentioned. Popularization of science and dissemination of scientific knowledge to the general public are two of the main objectives of all four foundations:
1) The Eugenidio Foundation organizes periodically a series of experimental interactive activities that are often related to chemistry and are designed to be as spectacular as possible. One of the permanent exhibitions of 'The Eugenidio Foundation' is an Interactive Exhibition of Science and Technology in which students have the chance to learn about matter and materials by interacting with the exhibits. Moreover, in a series of informal lectures entitled 'the café of science' the general public has the possibility to be informed on chemistry issues that are related to everyday life.

2) The NOESIS Science Center also organizes 'the café of science' lecture series, experimental activities with subjects that are related to chemistry. In addition, the 'NOESIS' center organizes 5-day summer camps for children between 9 and 12 years old. In the summer camp, children

are exposed to the world of science and technology via specially designed team games and activities, nature visits, showings (planetarium, documentaries), etc.

3*) The Industrial and Handicrafts Museum at Lavrion* is located in an area where mining activities and metal extraction (lead-silver) were actively taking place in the ancient times up until a few decades ago. The Museum organizes a series of educational programs designed in specific thematic areas and following the cross-thematic approach. Some thematic areas involve chemistry themes such as metal extraction from ore and metal reactions.

4) The Mining Museum of Milos, sited in Cyclades island, organizes annually a series of educational programs and activities aiming at increasing public awareness of the presence and use of minerals in every day life. Depending on their success some activities may go on for more than a year. Two of these activities that are related to mineral chemistry are the following: i) 'All Around Us: Minerals embrace our lives'- an educational board game available in Greek and English and ii) 'Minerals in our lives. Industrial minerals-our world is made of them'. This is an instructional and entertaining activity.

The Centers for Environmental Education (ΚΠΕ/ΚΠΕ) are non-formal educational structures that function under the auspices of the Ministry of Education, Lifelong Learning and Religious Affairs and are funded by the EU. They aim at developing the value of environmental responsibility among young secondary school children, at providing information showing the complex interrelationship between man and his natural environment, at creating a positive attitude towards scientific knowledge related to environmental science and at cultivating the ability for inquiry about the physical world. As an example, we can refer to the Center for Environmental Education in Argyroupoli [26], which is one of the first founded in Greece, in 1995. The center organizes a series of educational programs (7 active programs during 2010) which involve both classroom activities as well as field action, related to environmental themes. Field actions related with chemistry are, for example, the collection of water from a local river and then performance of simple chemical tests for determining its quality, evaluation of solid waste contamination etc.

Another non-formal educational initiative, functioning under the auspices of the Ministry of Education, is known in Greek with the initials *ΕΚΦΕ* (ΕΚΦΕ). ΕΚΦΕ stands for Secondary Education Laboratory Centers for Physical Sciences [27]. The personnel working at the 44 ΕΚΦΕs all over Greece (science teachers), give the opportunity to groups of secondary school children to perform chemistry experiments and aid teachers in designing and doing chemistry experiments in their own school units. They provide educational material and also organize events related to applications of chemistry in everyday life (informal lectures). They also prepare students for participating in the chemistry Olympiad and other chemistry competitions.

Science Fairs are an educational initiative organized by ΕΚΦΕs and sometimes by private institutions. The private secondary school 'Rhodian Pedia', located on Rhodes Island, organizes yearly a very successful science fair [28] that involves a series of demonstration experiments, fun activities and games in several scientific fields.

An important project, known as *PARSEL* (Popularity and Relevance of Science Education for Science Literacy) [29], is worth mentioning. PARSEL is a European Project carried out by a consortium of 8 Universities in 7 countries (Greece, Portugal, Sweden, Denmark, Germany, Estonia, Israel) and the International Council of Associations for Science Education (UK). It lasted for a total period of 30 months (ended in March 2009). During the project, alternative teaching material was developed and tested in order to promote popularization of science and increase the level of scientific literacy. The produced alternative teaching material aimed at promoting student interest in science without alienating the teaching from the curriculum intentions.

Second Chance Schools SDEs are part of the public school system and they are intended for adults (individuals over 18 years old) who have completed the first six years of compulsory education (Dimotiko) but not the extra three voluntary years of Lower Secondary School. Currently, there exist 57 such schools all over Greece and they are attended by approximately

5500 adult learners. Among other subjects taught, SDEs also include scientific literacy (Physics, Chemistry, Biology) in their curriculum. In other words, chemistry is not taught as a separate subject but integrated with the other physical sciences. In these schools, adult students learn modern science not with the traditional teacher-centered approach but mostly via performing simple experiments and by team-work and projects.

A major national strategy related to the promotion of life long learning is the new inter-disciplinary cross-thematic *Integrated Curriculum for Primary and Secondary Education* which was established in Greece in 2003 [30]. Except for the new curriculum, the new textbooks and supplementary educational material are yet to be produced. According to the new curriculum the presentation of the material should be spiral inductive, from the easy to the difficult. The students should be encouraged to search and discover new knowledge and the teaching method should take into account the pre-existing knowledge of the students (constructivism) and connect the chemistry class with their everyday experience. One of the main goals of the novel Curriculum is to provide students with the ability of 'learning to learn'. The competence of "learning to learn" is an obligatory requirement for engaging in lifelong learning.

6.5 Italy

Genoa Science Festival [31] 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.

Sciences Festival held in Rome [32]. This event is carried out annually and consists of a number of activities, 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.

Superquark [33] is the most popular TV program of scientific dissemination in Italy. Its success is due to the choice of subjects and to the simplicity of the language used by Piero Angela, the anchorman, and his team. It consists of 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') [34] 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. Television viewers can take part directly in the show sending questions and videos of scientific experiments carried out by themselves.

Focus [35] 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'* [36] is the largest science and technology museum in Italy. The Museum is housed in Milan 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 with 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')* [37] is the most innovative hands on museum in Italy, one of the largest and most important European Interactive museums. Every year new and topical conferences, seminars, exhibitions and laboratories are conducted in this space. Laboratories are addressed to everybody, but with 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* [38]. Minerva (www.minerva.unito.it) 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 site is constantly updated with news from the world of chemistry.

6.6 Turkey

Students' Achievement Determination Examination-2005 is a study which aims at determining the competency and achievement levels of students in the fields of Turkish, Mathematics, Science and Technology and Social Sciences. The study comprised of 153.462 students 4th, 5th, 6th, 7th and 8th classes of 829 public and private primary schools which were selected by random sampling from 81 cities of Turkey.

Development of *Lifelong Learning Project* aims at supporting cooperation, development of dialogue and networking process between all the parties related with Lifelong Learning, also encouraging educational institutions and sector to apply the awareness activities performed with the Lifelong Learning approach. The objective is to increase qualified education that is consistent with Lifelong learning strategies, and that addresses people in different age groups and education levels especially women, and is also consistent with developing technology and labor market and to establish an institutional frame that will certificate in accordance with European Union standards.

Invention Festivals which is organized by TUBITAK aims that students can approach events like a scientist and produce new projects. By working individually or in a group, students create original products with the assistance of a counselor teacher. Those products are evaluated by experts and the best inventions are rewarded. The aim of this initiative is to enable students to produce original inventions like a scientist.

National Chemistry Education Congress: Secondary Education Chemistry Educators' interest in chemistry education issues was determined during these congresses. The objective is to establish cooperation between national and international institutions that carry out chemistry

science and applications, and to spread the developments in that subject to every corner of Turkey.

National Green Box Environmental Education Project: Green Box Environmental Education Project which was created by Middle and Eastern Europe Environment Centre with the goal of providing environmental education and providing sustainable development was applied with the cooperation of the Ministry of National Education and the Ministry of Environment and Forestry in Turkey. The Green Box Environmental Education Project is a multimedia education resource package which aims students to be informed about environmental protection and sustainable development and increase awareness. The project aims to create environment knowledge and sensitivity.

Nature Training and Science Camps: Science and Social Projects aim information to be transferred to the society understandably, and while doing that it aims to visualize information as much as possible and to support it with interactive applications. In these projects the important thing is not transferring information as much as possible through classical education methods but to trigger curiosity and research and the learning desires by making participants aware of simple scientific facts.

Underwater Science Camps: The aim of Underwater Science Camps organized by TUBITAK is to enable students to solve the mysteries of the underwater. The requests of Science Camp by institutes are considered and supported. Underwater Science Camp teaches diving techniques to young scientists and candidates who think about working for scientific underwater projects, who are currently diving or want to have more experience by diving, and so help to find out and protect the riches in our seas, and to help to train qualified researchers.

6.7 Comparison among countries

Each country names and describes numerous national and local initiatives, selected paying special attention to chemistry.

They consist mainly of projects funded by the Government, but also in permanent centers for scientific expositions (i.e. museums), temporary expositions, seminars, festivals proposing a wide variety of activities as well as a 'hands on' approach allowing for the active participation of the public.

Many projects are entrusted to universities and aim to attract the interest of secondary school students by showing topical but also amusing and, sometimes, spectacular aspects of chemistry. A common point of the projects is the care in showing the link between chemistry, an apparently abstract discipline, and everyday life.

Other projects worth mentioning are devoted to research in the field of methodology of teaching. They aim to improve the teaching-learning of chemistry and provide training for teachers and useful materials for both teachers and students.

7. Identification of best strategies and effective science education initiatives

7.1 Bulgaria

Some of the interviewed teachers have taken part in projects and initiatives under the national or regional programs as ‘School as a means to discover yourself ‘ (under operating program ‘Human Resources Development’ 2007-2013), Ministry of Education program ‘Making school attractive to young people’, National program ‘ School – the territory of students’ etc.

Based on their professional experience in didactic and chemistry teaching they conclude that personal attitude largely determines whether someone will continue university studies in certain area/subject (chemistry included). The Secondary school is the venue where this attitude is generated. How the subject is taught is of crucial importance as well as its further practical applicability. But It is difficult to propose successful approaches due to one main reason: the lack of possibilities to make self-realization by employing knowledge in chemistry in the period after school graduation. There is no demand for chemistry specialist on the job market.

Despite this, effective educational initiatives should stimulate the interest in learning chemistry, at school and after, during the course of everyone's life, according the following steps:

- Young people should be offered clearly defined prospects for self realization and professional progress; there should be developed new conditions for self-realization of young people within Bulgaria, not outside it.

- New hybrid more attractive specialties are to be developed such as computational chemistry, for example.

- Novel innovative methods of training are to be introduced relying heavily on it - projects, electronic course books, software. In the sphere of chemistry all these are very few in number and of limited content [39,40].

- The material taught should be oriented to practice.

- At last but not least, student’s own personal initiative and inquisitiveness in the field of chemistry is also required.

According with these considerations, the best practices are considered those providing a practical approach to scientific disciplines and a first person involvement of students. Moreover projects and initiatives based on interdisciplinarity (i.e ‘Chemistry on the stage’ or ‘Different school common problems’) and/or aimed at showing the link between sciences (chemistry in particular) and everyday life are particularly appreciated by most people, students as well as adults and teachers (i.e. Mosaic of science and culture, Water and water mills, past and present)

7.2 Czech Republic

Effective education initiatives to overcome the barriers to learning of scientific subjects can be summarized as follows:

- the method of teaching should be improved, as well as conditions and facilities for teachers (including the quality of their life long education, touch with current developments in research and science, improvement of teaching materials and equipment, etc.);

- prestige of research and researchers in society should be enhanced; young people must see the perspective in the terms of prestige, prospect and income as well; they must know that there are interesting and prestigious jobs waiting for them after they complete their studies. The examples of rewarding career should be presented;

- ‘bad image’ of chemistry should be abandoned – the way to this goal is to popularize chemistry and chemists; to show it in the context of our everyday life and researchers as modern people;

- the curricula of chemistry at schools should be modernized to face the interest of the society (less memorizing of theory, more about up to date issues – pharmacy, drugs, food safety, modern materials, etc.).

The identification of the best strategies, listed in paragraph 6, suggests that, to change the attitude of society to natural science and chemistry in particular it is necessary to improve:

- popularization as a first step to awaken the interest of people that may lead to further education in the area;

- education of teachers (Summer School of Modern Chemistry);

- improvement of teaching materials (Lessons of Modern Chemistry, POPuch, ECHO, EURO, CITIES);

- attracting young people to study science (Open Science, Support for Technical and Natural Science Subjects);

- attitude of society (Czech Head);

- spread the information about the possibilities to study chemistry (Scientia Pragensis, Gaudeamus);

- improve the image of chemistry – to show it in its modern and positive form and in the context, to show its application in industry (ChemPoint).

7.3 Germany

The Federal Ministry of Education and Research initiated and strongly supports numerous kinds of facilitation and promotion for scientifically and technically based continuing vocational training programs or studies:

· early contact with regional companies and networks

· internships facilitating learning modules for pupils in need of special support

· individualised, tailor-made modules

· consultancy, advisory and matching of pupils and companies

· gender sensitive approach

7.4 Greece

Best strategies and effective education initiatives to promote lifelong learning of scientific subjects are focused on the strengthening of the teaching–learning process. They can be summarized in the following points:

- training of chemistry teachers (i.e master program ‘Chemical Education and New Educational Technologies’)

- use of museums as non-formal educational structures. The interactive experimental activities and exhibits seem to be the ones that are more positively received by the public. The

educational programs should be carefully designed by respecting pedagogical theory and should be attended simultaneously and in close connection with the traditional classroom activities, in order to achieve the most permanent educational result.

- involvement of students in scientific activities organized by experts (i.e Centers of Environmental Education, Secondary Education Laboratory Centers for Physical Sciences);

- development of tools and alternative teaching material (i.e PARSEL project) to be used by teachers.

- Curriculum content and design is of critical importance. The new interdisciplinary cross-thematic Integrated Curriculum for Primary and Secondary Education (based on knowledge discovery and taking into account pre-existing knowledge) is definitely a good strategy. Its realization however is far from easy. Novel textbooks need to be produced, school laboratories need to be adequately equipped both with instruments and with personnel and more time needs to be allocated for practical experimentation.

Concerning tools and alternative teaching method, a careful investigation has been carried out (please, for a detailed discussion, see the National Report) and a noteworthy selection is reported below.

Communication and Information Technology (ICT) in Chemistry Education can lead to a remarkable improvement in chemistry teaching, stimulate student interest, enhance the educational result and promote lifelong learning. They should be used however as supplements and tools for achieving the ultimate education goal.

The performance of chemistry experiments by the students themselves (and at least the use of demonstration experiments) has been identified as most effective in creating positive attitudes and in achieving a more permanent educational result.
Among the non-traditional teaching methods the ones identified as most effective in promoting lifelong learning are the following: i) the use of carefully designed analogies in Chemistry teaching, ii) the 'three-cycle' method based on the distinction into the macroscopic, submicroscopic and symbolic levels, iii) the use of press articles which have been carefully transformed into educational material, iv) the method of guided inquiry, v) a hybrid instructional method involving both web-based and in-class learning and vi) the constructivist methodological approach. Constructivism takes into account the student's previous (incorrect) knowledge and common misconceptions. It is considered very effective, however at the same time difficult to put into routine practice.

The use of science textbooks which do not follow the traditional teaching method (teacher-centered and the student treated as 'blank paper'), but make use of either guided inquiry or of constructivism seems to be also an effective initiative

The interdisciplinary teaching approaches are also very effective in showing the close interconnections between different scientific fields. Many everyday life phenomena, especially those that are related with the environment, require the engagement of several different scientific disciplines for their full explanation.

7.5 Italy

The effective education initiatives to improve lifelong learning of scientific subjects, chemistry in particular, are mainly linked to early education (up to high school) and are focused on teaching methodology and teacher training.

Concerning teacher education, 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 shown a noteworthy improvement of their chemical culture and of their teaching methods.

For the same aim, SSIS schools (Graduate Schools for Secondary School Teachers) has to be considered relevant [41]. 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 for teachers than graduation. The evaluation of the work of 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.

Very important education initiatives, devoted to adult education, are alternative universities, such as UNITRE and the Popular Universities. Unfortunately, their main fault is the lack of a real offer in terms of scientific courses, that are sporadic and deal 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 most impressive results of the interviews performed are the bad reputation of chemistry and the poorness of the average knowledge of the latter. Therefore the best strategies aim to show a positive, realistic and, when suitable, amusing image of this discipline by using popular media (such as TV and newspapers) and social events.
TV broadcasts such as Superquark or The Gay Science, are very good tools that introduce in an easy, elegant and attractive way even complicated concepts. Also other initiatives, such as the Genoa Science Festival with its 'hands on' approach to science, are to be numbered among the most useful and successful in the frame of lifelong learning.

7.6 Turkey

When the studies are examined generally, it is seen that the application of the constructivist approach, which includes the basic logic in new science and technology curriculum, has an important effect on students' learning. Students' previous learning experiences are important in the constructivist approach. Their having misconceptions, wrong previous knowledge will be detrimental to their future, lifelong learning activities.

7.7 Comparison among countries

Partners agree in considering excellent strategies involving students and adult people in practical activities able to show the positive and topical aspects of chemistry. In such a way the bad image of chemistry, often considered as a dangerous, abstract and difficult subject, can be improved.

But the above activities are not, of course, considered sufficient. Indeed, in common partner's opinion, the fundamental actions consist of improving the teaching-learning process and the latter can be achieved according to the following ways:

- providing continuous training to chemistry teachers

- involving students in scientific activities at school with their teachers, but also outside school (i.e. at universities or companies and organized by researchers and experts)

- developing tools and alternative teaching material to be used by teachers.

Concerning tools and alternative teaching method, the interdisciplinary teaching approaches help the ability of ‘learning to learn’ are very effective in showing either the interconnections between different scientific fields or the concrete aspect of chemistry.

Furthermore the use of science textbooks which do not follow the traditional teaching method (teacher-centered and the student treated as ‘blank paper’), but make use of either guided inquiry or of constructivism seems to be also an effective initiative.

Finally the constructivist methodological approach is considered very effective because it assigns students an active role in the teaching-learning process, develops their critical and conscious attitude and is able to correct common misconceptions.

8. Conclusions and strategy proposal

8.1 Bulgaria

The National policy in the field of education including Life Long Learning is based on the analysis of the international practices and the tendencies specific for the country the economic and social development.

In these conditions Life Long Learning not only contributes to keeping the high competitiveness and of the potential opportunities for ensuring employment but it is also the best way to fight with the social rejection.

The analysis of the practices in lifelong learning activities shows that in spite of some differences, there is a core of common principles as a basis for LLL strategies:

a) Approval of the flexibility as a basic organizing principle for the university education. It is expressed in:

- Expansion and diversification of the access to the university through creation of opportunities for qualification improvement without being necessary to finish a complete program as well as giving credits for available professional experience;

- different ways for education which allow learning to be successfully combined with work or family engagements;

- a strong market orientation of the courses and their conformation with the requirements of the employers.

b) Recognition in higher education of knowledge and skills acquired in an informal way before entering university.

c) Guarantee of the quality of the higher education through differentiation at the exit of the high schools.

Giving careful consideration to these factors, the Ministry of Education has worked out a national strategy for the development of education with several priority trends which aim at providing:

- quality of education;

- equal access to education and opening of educational system;

- conditions and environment for practical implementation of the 'lifelong learning' concept, turning Bulgaria into a country in which knowledge and innovations are the drivers of economy.

Concerning 'lifelong learning' concept the efforts are directed toward [42]:

- Improvement of methods of adult training and incorporation of interactive forms of teaching such as case studies and simulations;

- Adoption of normative extenuations for physical and legal entities in conformity with the practice of other European countries aiming at the stimulation of lifelong learning and continuous efforts to raise the quality of knowledge and skills;

- Binding lifelong learning with career development.

The practical instruments for effective implementation of this policy are found in:

- Developing effective partnerships between universities, employers and NGOs for the purpose of implementing continuous education;

- Provision and encouragement of access to various forms of continuous education aiming at acquisition of the new skills needed;

- Developing and offering new approaches and standards in teaching and learning which underwrite the application of world standards for lifelong learning in Bulgaria;

- Development and introduction of a system for assessment and validation of lifelong learning;

- Developing a National qualification frame for lifelong learning which will indicate learning outcomes [2,3].

8.2 Czech Republic

Although there have been many successful projects and initiatives aimed at the development and support of LLL, it's development in the Czech Republic remains rather slow. For example, general analysis and evaluation of the education projects financed from the resources of the EU and the state budget is missing.

Based on our findings, we would like to point out the following conclusions:

Legal framework exists in compliance with the EU legal framework; the Czech Republic has an advantage as a recipient of the EU funds.

It would be desirable to improve the coordination not in the sense of central management, but in the sense of the sharing of information and best practices.

The link between education sphere, research and industry should be strengthened.

The quality of teaching natural science, the quality of teachers as bearers of ideas and enthusiasm to the students should be improved and students should see the perspective of career and prestige in science and research oriented jobs.

Chemistry should be generally presented in a positive way in the context of all aspects of life (ecology, alternative sources of energy, nature, preservation of cultural heritage, safety of food, health care, etc.).

8.3 Germany

The Expert Group on Science Education of the European commission published a brochure entitled: Science education NOW: A renewed pedagogy for the future of Europe. In summary, the experts say the following:

A shift from mainly deductive methods, to more investigated learning in the education in science provides the ability to arouse greater interest in science.

A renewed education in science based on investigated learning provides more opportunities for cooperation between professional job related and other education stakeholders.

Teachers play an important role in the renewal of science education. They can improve the quality of their teaching and strengthen their motivation by joining a network.

In Europe, these important components of the renewal of teaching methods in science subjects are promoted by two innovative initiatives "Pollen" and "Sinus-Transfer", with which the interest and knowledge of children in science subjects already could be increased and improved. With a few adjustments these initiatives could be effectively carried out in such a scale, that the desired breadth can be achieved.

The group has 6 recommendations:

Recommendation No. 1: Since Europe's future is at stake, decision makers need to claim measures to improve science education at the institutions which are responsible for the implementation of changes at local, regional, national and European level

Recommendation No. 2: Improvements in science education should be complemented by new educational methods. The introduction of a concept, based on investigated learning in schools, measures to train the teachers in this kind of learning method and the development of teacher networks should be actively encouraged and supported.

Recommendation No. 3: It should be especially cared for that the participation of girls in important scientific school subjects is increased and that they can develop greater confidence in the Sciences

Recommendation No. 4: Measures should be introduced to promote the participation of cities and local communities in the renewal of science education through joint action at European level, to accelerate the change by the exchange of know-how.

Recommendation No. 5: The coordination between national activities and those funded at European level should be improved. In addition, opportunities for increased support through the instruments of the Framework Program and the programs in the field of education and cultural initiatives that are created as example pollen and Sinus-Transfer should be expanded.

Recommendation No. 6: A European Committee for Science Education (European Science Education Advisory Board) should be established with representatives from all interest groups and supported by the European Commission in the scope of science and society.

8.4 Greece

The main obstacles to lifelong learning of scientific subjects and more specifically chemistry are related to either the nature of chemistry, or students' difficulties, or students' attitudes toward chemistry. Identification of these barriers is a prerequisite for the design of an effective strategy for promoting lifelong learning in scientific subject and for overcoming scientific illiteracy.

The most effective science education initiatives for promoting lifelong learning are related to the following: Communication and Information Technology in Chemistry Education, Non-traditional teaching methods, Interdisciplinary teaching approaches and hands-on teaching approaches.

A strategy proposal for the promotion of lifelong learning should be based on both the views of the students/adult learners and the teachers. It should take into account the difficulties, attitudes and needs of the first and at the same time the beliefs of the second regarding their work context.

On the base of the above conclusions the proposed strategy is based on three pillars: i) Teaching methodology, ii) Non-formal educational initiatives, iii) Curriculum design.

- Teaching Methodology

Chemistry teaching should take into account students' previous knowledge and misconceptions and follow the method of constructivism in order to achieve the required mental change. This requires that research on identifying these misconceptions should be encouraged.

Chemistry teaching should also take into account the specific difficulties that students encounter, as those have been identified by continued and intensive research. Chemistry is a subject that often requires high conceptual demands from the students and its difficulty discourages them from even making an effort to understand it. Teachers should not deny that Chemistry can be difficult, they should however stress to the students all possible gains they

can have by investing time and effort in learning such a subject: they will end up with higher self-esteem after their successful encounter with chemistry, they will have cultivated their critical, complex, and analytical thinking and judgment, they will be able to act as responsible citizens in a constantly-changing world, they will become smarter. These gains are worth obtaining regardless of the actual profession that someone practices.

The use of novel educational tools based on ICT can provide valuable assistance to the process of making Chemistry teaching more attractive and more effective. However, it should not constitute the major teaching method, but act complimentarily.

Hands-on experimentation should be encouraged. It helps making students' attitudes more positive, it increases their interest to the subject and puts chemistry 'in context', i.e. shows its connection with everyday life phenomena.

Non-traditional teaching methods (guided inquiry, combination of in-class and long-distance learning, articles from the press, analogies) as well as interdisciplinary teaching approaches aid in cultivating the ability of 'learning to learn'.

Last and most important, special emphasis should be given to teachers' training and continued education on these methodologies. Teachers' beliefs concerning their work context should seriously be taken into account by policy makers [43, 44]. Teachers should be aware of the advantages and disadvantages of each teaching approach and they should be given advice (not orders) and practical help for their implementation.

- Non-formal and Informal educational initiatives

Educational programs, interactive exhibits and hands-on activities organized by science museums can be a very effective means for dissemination and popularization of scientific knowledge. However, students' attitudes towards science do not seem to change significantly after the visit to the museum. The goal of cultivating an inquiring mind is better served via a combination approach: in-class preparation for the museum visit, careful design of the activity/ies carried out at the museum, knowledge enhancement after the visit (meta-knowledge) and visit evaluation.

The educational initiatives undertaken at regional level by the Centers of Environmental Education (ΚΠΕ/KΠΕ) and the Secondary Education Laboratory Centers for Physical Sciences (ΕΚΦΕs), if properly disseminated among teachers and students, constitute an important strategy for promoting lifelong learning. The most effective initiatives are actions in the field and the possibility of setting up easy to do experiments in a school laboratory with very simple materials.

Alternative educational material produced by projects such as PARSEL [29] and our own ('Chemistry is All Around Us') constitute an effective route to the promotion of lifelong learning of scientific subjects. This material should be designed so that it is entertaining, user friendly and at the same time scientifically sound. It should include different levels of difficulty, bring out the presence of chemistry in many aspects of human life, not necessarily deny the negative results of chemistry but also point out the positive ones which are far more numerous.

- Curriculum design

The length of the Chemistry syllabus and the amount of time allocated to Chemistry teaching should coincide so that it is possible for the teachers to present the material in depth and for the students to assimilate it. The content of the curriculum should give emphasis to the application of the presented principles to real life phenomena. The active student involvement in lab experimentation should be supported by lab personnel and by the allocation of a specific slot in the weekly timetable for lab work.

The Chemistry curriculum should take into account students' alternative ideas and give emphasis to interdisciplinarity. However, chemistry education needs not to be integrated with

other physical sciences in a sole 'science' course. The presentation of the material should be spiral inductive, i.e. from the simple to the complicated, from the easy to the difficult. Students should be encouraged to search and discover new knowledge, to understand principles and learn the least possible by heart and most importantly to master the ability of 'learning to learn'.

8.5 Italy

Our research has described and analyzed the main traceable documents in literature and many local, national and European initiatives, aimed at encouraging a lifelong scientific learning for the citizens (where with "lifelong learning" we mean an education crossing ages and different aspects of life, thus integrating initial and continuing paths, scholastic and not, formal and informal).
Each and every cultural, economic and political aspect of society is concerned with scientific issues, more or less "accessible" for the so called "common people", who are daily asked to make choices with heavy consequences on the health of individuals, community and environment.
From this point of view, a basic scientific knowledge is a necessary condition for such choices to be as rational as possible rather than emotional, autonomous rather than easy to be manipulated and orientated from outside.
Science (as confirmed by the interviews carried out) is perceived by many people as hard, difficult to access, abstract, far from everyday life. Moreover, chemistry has an undeserved negative halo: it's often associated to problems such as pollution and drugs and opposed to "natural", usually considered, on the contrary, as a synonym for healthy, authentic, genuine, better.
But, how can the adult citizen be made aware and responsible on these themes?
The present initiatives (museums, festivals, popular scientific press and TV programs, …), though positive because aimed at awakening public opinion and bringing people nearer to the world of research and science, can't make up for a possible lack of cognitive tools, abilities and competences that must be pursued at school.
Scientific popularization is often considered a valid substitute for didactic, but many are the reasons why it can't be completely effective as the fact that every message addressed at a inhomogeneous public, carries inevitable problems linked to its intelligibility, because every receiver has a different cognitive fund.
For this reason, we don't think it's enough to invest in this direction, even if it's surely useful to motivate, arouse curiosity and promote a positive attitude towards chemistry and science. In fact the risk is to make people think they understand matters that are actually much more difficult, even for the "experts".
The information given by the media may be correct and accurate, but we think that the basis of a scientific culture should be built up starting from primary education, through strategic investments in educational research and in the teacher training. The easiness of information finding, granted by the spreading of technologies and internet, sometimes only consolidate some spontaneous beliefs: inserting keywords in a search engine immediately gives a set of more or less concordant answers but, in order to evaluate the quality of a piece of information, it's necessary to possess some previous knowledge.
Only a renovated scientific teaching, privileging a methodology that aims, from the beginning, at developing cross-curricular abilities as opposed to a mnemonic and superficial knowledge of notions, will give back to science its formative and cultural dimension.

8.6 Turkey

The misconceptions of the students who study scientific subjects should be identified and eliminated with conceptual substitution texts, which are used for removing concept errors.

8.7 Comparison among countries

At the second Project Meeting (Berlin 6-7 September 2010) each partner presented detailed conclusions on the basis of information derived from the activities carried out (interviews and reviews of papers and strategies) and proposed a strategy to implement Life Long Learning of scientific subjects, chemistry in particular.
A very stimulating discussion among partners produced the agreement for a common and concrete approach. The detailed strategy is described in the document entitled 'Strategy Proposal', uploaded on the project portal.

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