STENCIL
SCIENCE TEACHING EUROPEAN NETWORK FOR CREATIVITY AND INNOVATION IN LEARNING

Enhancing Innovation and Creativity in Science Teaching

STENCIL Annual Report n.1

e-Book

Education and Culture DG

Education and Training

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EDITORS

Kathy Kikis-Papadakis, Francesca Magrefi, Renia Papanastasiou

CONTRIBUTORS

Luis Alves, Guillaume Anderbourg, Stanko Blatnik, Marta Consolini, Tiziana Cremonini, Mila D'Angelantonio, Annalise Duca, Kerry Freeman, Todorka Glushkova, Alper Güngör, Klaus-Peter Haupt, Gospodin Jelev, Philippe Leclère, Maja Lipnik, Yoana Minkova, Sibylle Moebius, Viliya Nejkova, Iari Nora, Marco Pereira, Giulia Piscitelli, Cristina Proença, Pedro Ramalho, Cyrille Raymond, Eduardo Ribeiro, Rafael Santos, Evelyn Schlenk, Jörg Steiper, Riccardo Tiddi, Bahri Turunç

EXPERT CONTRIBUTORS

Mario Barajas, Peter Csermely, E.N. Economou, Martin Owen, Monica Reti, Anna Trifonova

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DESIGN

Yorgis Androulakis, Stella Melina Vasilaki

PHOTOS

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PREFACE: CURRENT TRENDS IN SCIENCE EDUCATION

It has been a few decades now since decision makers recognized that science teaching and learning within a mass education perspective requires considerable changes from the traditional elitist perspectives on learning. While education and science teaching specialists in Europe were active in advocating and substantiating requirements for change, it was not until the European Commission, Directorate-General for Research, Information and Communication Unit commissioned back in 2007 a group of experts to review the on-going initiatives and good practices and on such a basis introduce radical changes for the interest of young people in science studies. The report, widely known as the Rocard Report, has become an impetus for a great many reforms in the way we conceive and practice science education.

This document, developed in the frame of the STENCIL NETWORK, aims to highlight INNOVATIVE and CREATIVE PRACTICES in Science teaching as a tool for considering improvement in science teaching by teachers and educational designers. The book draws contributions from a selected group of professionals that have been active in the reform framework put forward by the Rocard orientation to STEM teaching. These contributions aim to raise awareness on key developments, concerns and challenges both at the teaching and policy levels.

The STENCIL e-Book highlights the current trends in science education, as these are expressed in the practices of teachers across Europe and contribute to the improvement of educational performance for the individual learner and the system as a whole. In this document, the position of science education in the recent educational reforms is discussed as is the relative position of a set of countries in international studies. Special emphasis is given in the dimension of teacher training- both at the initial and in-service levels, as teacher training constitutes the vehicle that can contribute to the widespread of INNOVATION and CREATIVITY in the educational provisions.

The book is divided in three interrelated parts, those being

I. European Framework for Science Education

Addressed are the dimensions of Science Education within the educational systems in Europe with discussions on Bulgaria, France, Germany, Greece, Italy, Malta, Portugal, Slovenia and Turkey (STENCIL participant countries)

as well as a comparative review of international studies and Teacher Training Practices in the STENCIL partner countries.

II. Innovative EU Projects and Initiatives

Highlighted is what constitutes Good Practices in Science Education from a review of literature perspective as demonstrated by a set of selected projects/initiatives that address the elements of

- Teacher Training

- Collaborative approaches
- New pedagogical approaches
- Key competences development
- Diversity

Examples of innovative practices on these elements are presented. These are divided into cases reported by the STENCIL partners as innovative on the basis of a common grid and cases that were compiled from recently EU funded projects.

III. Moving forward: knowledge sharing for improvement

The book concludes with a section in which the principle factors that imply INNOVATION and CREATIVITY in Science Teaching and selected conferences in the thematic orientation of science education are highlighted.

Enjoy your navigation into the State-of-Affairs, from an INNOVATION and CREATIVITY perspective, on Science Education in Europe.

Kathy Kikis-Papadakis

FORTH/IACM

INTRODUCTION: STENCIL NETWORK

STENCIL is a Comenius Network funded with support from the European Commission within the Lifelong Learning Programme, from January 2011 to December 2013. STENCIL includes 21 members from 9 different European countries: Bulgaria, Germany, Greece, France, Italy, Malta, Portugal, Slovenia, Turkey, working together to contribute to the improvement of science teaching, by promoting innovative methodologies and creative solutions that make science studies more attractive for students. Among the partners there are schools, school authorities, research centres, universities, science museums, and other types of organisations, representing different points of view on science education.

STENCIL offers to science teachers, schools, school leaders, policy makers and all practitioners in science education from all over Europe, a platform - ***www.stencil-science.eu*** - to encourage joint reflection and European co-operation, also offering high visibility to schools and institutions involved in Comenius and other European funded projects in science education.

The concrete objectives of the STENCIL Network are the following:

To identify, evaluate and promote innovative practices in science teaching, by publishing every year an Annual Report on the State of Innovation in Science Education;

To bring together science education practitioners to share different experiences and learn from each other by organising periodical study visits and workshops, in a peer to peer approach;

To disseminate materials and outcomes coming from previous European funded projects, but also from isolated science education initiatives, through the STENCIL web portal and online communities, as well as through a wide range of dissemination actions, such as international conferences and national dissemination events;

To provide educational authorities and policy makers with a set of Guidelines and a Manifesto for innovating science education in their countries, especially focused on the establishment of contacts between Research Institutes, Schools and Industries.

STENCIL is based on the results of two former European projects**: STELLA - Science Teaching in a Lifelong Learning Approach** and **GRID - Growing interest in the development of teaching science**. The STELLA project - *http://www.stella-science.eu* - was funded with support from the European Commission within the Lifelong Learning Programme, taking place from January 2008 to December 2009. It aimed at contributing to the improvement of science teaching in European schools, in particular in order to stimulate young people to undertake science studies and careers. The *STELLA eBook "Science Education in European Schools – Selected Practices from the STELLA Catalogue"* illustrates selected practices identified among more than 800 projects included in the STELLA Catalogue of Science Education Initiatives.

The STELLA project extended the results of the former European project **GRID -** *http://www.grid-network.eu* - by enriching and further developing the Online Catalogue of Science Education Initiatives already created in this framework, and by disseminating it among new users all over Europe. The GRID project (2004-2006), funded within the framework of the EU Socrates Programme, had the objective of creating a network for the exchange of good practice in the field of science teaching in Europe, at the level of decision makers and schools directly involved in innovation and experimentation in the broad area of science education. In this frame, an international survey was carried out to identify policies and innovative initiatives all over Europe. The results of this survey have been made accessible through two online catalogues which include respectively more than 500 initiatives and 70 reports and recommendations on subjects related to science education.

Taking advantage of the results of the former projects, STENCIL partners are now working to develop the following outcomes:

European Online Catalogue of Science Education Initiatives, including initiatives directly submitted online by teachers and schools from all over Europe by filling in a questionnaire which documents the key elements of the school practices. The STENCIL Catalogue offers to teachers and all persons interested in science education the possibility of publishing their science education projects and inspiration from searching for initiatives within different subjects from other schools and countries. In the STENCIL Catalogue there are already over **900 initiatives**, based on the activities done by the former projects STELLA and GRID.

Annual Reports on the State of Innovation in Science Education, including the results of the joint reflection on science education themes and models carried out

by STENCIL members as well as the detailed descriptions of the innovative practices identified at national and European level. The present report is the first STENCIL Annual Report. The 2nd and the 3rd Reports will follow, respectively, by the end of 2012 and 2013.

Study Visits & Workshops are regularly organised from / to schools and other partner institutions in order to illustrate good and innovative practices in science education. A total of 7 study visits & workshops will take place in the 3 years of the project duration in the following countries: Italy, Greece, France, Portugal, Germany, and Malta. STENCIL events are open to teachers, school managers and all persons interested in science education. Multimedia documentation of each study visit and workshop, including videos, photos and PowerPoint presentations, is available on the STENCIL web portal Transfer section[1].

International conferences are organised every year in France (2011), Germany (2012) and Italy (2013), addressing teachers, school managers, teacher trainers, school authorities, policy makers, and all key players in science education in order to promote the Annual Reports as well as to present the good practices identified in this framework. They also provide occasions of informal exchanges, common reflections and debates, as well as working sessions and social events.

Call for participants is launched every year, to award science education projects carried out in schools that are inspired by good practices and criteria described in the STENCIL Annual Report.

The **Guidelines and Manifesto** for teaching and learning science in a creative way will be issued by the end of 2013 and will remain at the disposal of all stakeholders and practitioners in science education, providing tools and models for innovating science education.

All the STENCIL products are made freely available from the STENCIL web site, according to the aim of the network which is to contribute to the improvement of science teaching in schools all over Europe and to promote innovative methodologies and creative solutions that make science studies more attractive for students.

[1] *http://www.stencil-science.eu/study_visits_workshops.php.*

PART I:

EUROPEAN FRAMEWORK FOR SCIENCE EDUCATION

CONTRIBUTION: FRANCESCA MAGREFI AMITIÉ, ITALY

The **Lisbon strategy** set out in March 2000 by European Union leaders, convened in the Lisbon Summit with the aim **to make Europe more dynamic and competitive**. The overall goal of the Lisbon Agenda was to make - by 2010 - Europe *the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion*[2]. The strategy recognised the role education and training play in the development of today's knowledge society and economy. The **improvement of Maths, Science and Technology graduates by at least 15% over the number in 2000 and better gender balance** was set as one of the five benchmarks to be reached by 2010[3].

In 2002 the European Commission published a **Science and Society Action Plan**[4] with aim of pooling efforts at European level **to develop stronger and more harmonious relations between science and society**. The plan was intended to support the strategic goal set by the European Union in Lisbon and other important Community debates and processes such as the creation of the European Research Area and the implementation of the White Paper on European Governance and the debate on the future of Europe. Within the Plan 38 concrete actions were proposed, to be undertaken jointly with the Member States, regional authorities, scientists, policy makers, business, civil society organizations and other stakeholders, in the form of specific research, networking and exchanges, public events and initiatives, prizes, surveys and data collection.

The **Education & Training 2010 Work Programme (ET2010),** adopted by the Barcelona Council in March 2002, brought together all initiatives in progress in the area of education and training to enhance coherence and effectiveness. The work

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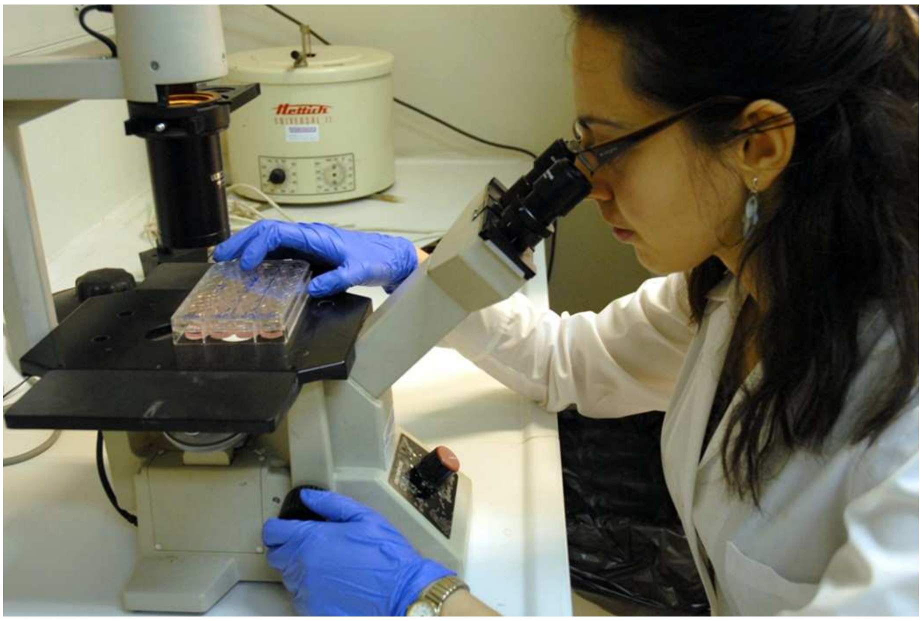
[2] European Commission 2000, Lisbon European Council 23 and 24 March 2000, Presidency Conclusions - *http://www.europarl.europa.eu/summits/lis1_en.htm*.

[3] The five benchmarks are the following:

- Reading literacy: at least 20% fewer low-achieving 15 year olds than in 2000
- Upper-secondary completion: at least 85% of 22 year olds
- Maths, science, technology: at least 15% more graduates than in 2000 and better gender balance
- Lifelong learning participation: at least 12.5% of 25-64 year olds
- Early school leaving: no more than 10%

[4] European Commission 2002,Science and Society Action Plan - *http://ec.europa.eu/research/science-society/pdf/ss_ap_en.pdf*

programme was based on three strategic targets: a) **quality** and effectiveness of the education and training systems; b) **accessibility** of the systems to everyone, as part of a lifelong learning approach, and c) **openness** of the systems to society and the rest of the world. "***Increasing number of graduates in science and technology***" was one of the 13 specific targets into which the 3 common strategic goals were sub-divided. Within this framework 8 Peer Learning Clusters were established, applying the 'Open method of Coordination' that aims to help Member States to critically reflect upon their own polices in the context of European cooperation and to learn from other countries' practices[5].



In 2006 the **Recommendation of the European Parliament and of the Council on Key Competences for lifelong learning** presented a new European reference tool for key competences and highlighted the need to ensure access to these competences to all citizens through lifelong learning. Key competences are defined as a **combination of knowledge, skills and attitudes appropriate to the context**. Key competences are those which all individuals need for personal fulfilment and development, active citizenship, social inclusion and employment. By the end of initial education and training, young people should have developed the key competences to a level that equips them for adult life, and they should be further developed, maintained and updated as part of lifelong learning. **Mathematical competence and basic competences in science and technology** is one of eight Key competences identified in the Recommendation[6].

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[5] European Commission 2003, Commission Staff Working Document - Implementation of the "Education & Training 2010" programme - *http://ec.europa.eu/education/policies/2010/doc/staff-work_en.pdf*

[6] Recommendation of the European Parliament and of the Council on Key Competences for lifelong learning - 2006; *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:394:0010:0018:en:PDF*
The 8 Key competences are the following: Communication in the mother tongue; Communication in the foreign languages; Mathematical competence and basic competences in science and technology; Digital

Within this document the **Mathematical competence** is defined as: "*the ability to use addition, subtraction, multiplication, division and ratios in mental and written computation to solve a range of problems in everyday situations. The emphasis is on process and activity, as well as knowledge. Mathematical competence involves - to different degrees - the ability and willingness to use mathematical modes of thought (logical and spatial thinking) and presentation (formulas, models, constructs, graphs/charts)[7]".* Essential knowledge, skills and attitudes related are also defined for each competence. With reference to Math competence **the need for individuals to skills to apply basic mathematical principles and processes in everyday contexts at home and work, is emphasized.**

The **Scientific competence is defined as** "*the ability and willingness to use the body of knowledge and methodology employed to explain the natural world, in order to identify questions and to draw evidence-based conclusions. Competence in technology is viewed as the application of that knowledge and methodology in response to perceived human wants or needs. Both areas of this competence involve an understanding of the changes caused by human activity and responsibility as an individual citizen*[8]". For this competence **skills include the ability to use and manipulate technological tools and machines** as well **as scientific data** to achieve a goal or to reach a decision or conclusion, based on evidence. The positive **attitude** is based on critical appreciation and curiosity, an interest in ethical issues and respect for both safety and sustainability - in particular as regards scientific and technological progress in relation to oneself, family, community and global issues.

In the same year - 2006 - the European Commission appointed a group of experts chaired by the former French Prime minister Michel Rocard with the task to "*examine a cross-section of on-going initiatives and to draw from them elements of know-how and good practice that could bring about a radical change in young people's interest in science studies - and to identify the necessary pre-conditions[9]*". The findings and recommendations of this group are summarized in a report issued on 2007 with the title "**Science Education now: A Renewed Pedagogy for the Future of Europe" -** the so called "Rocard Report". The report found the origins of the declining interest among young people for science studies in the way science is taught in *schools. In fact "whereas the science education community mostly agrees that pedagogical practices based on inquiry-based methods are more effective, the reality of classroom practice is that in the majority of European countries, these methods are simply not being implemented"[10].* The report stresses the importance

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competence; Learning to learn; Interpersonal, intercultural and social competences and civic competence; Entrepreneurship; and Cultural expression.

[7] Recommendation of the European Parliament and of the Council on Key Competences for lifelong learning - 2006; *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:394:0010:0018:en:PDF*

[8] See above

[9] Rocard et al. (2007) High Level Group on Science Education, Directorate General for Research, Science, Economy and Science, European Commission, Science Education Now: A Renewed Pedagogy for the Future of Europe. *http://ec.europa.eu/research/science-society/document_library/pdf_06/report-Rocard-on-science-education_en.pdf*

[10] See above

of the **inquiry-based methods as a means to increase children's interest** in science and to provide **increased opportunities for cooperation between actors in formal and informal education**. **Teachers** are recognized as **key players in the renewal of science education** and **networks as an effective component of teachers' professional development**. The Report identifies 2 initiatives as good practices - **Pollen[11] and Sinus-Transfer[12]** - to be effectively implemented and transferred to renew science teaching practices and increase children's interest and attainments in sciences. The Report draws 6 Recommendations that had - and still have- a deep influence on European and national actions and policies towards a change in science education.

Because Europe's future is at stake decision-makers must demand action on improving science education from the bodies responsible for implementing change at local, regional, national and European Union levels.

Improvements in science education should be brought about through **new forms of pedagogy,** the introduction of inquiry-based approaches in schools, actions for teacher training in IBSE, and the development of teachers' networks should be actively promoted and supported.

Specific attention should be given to raising the participation of girls in key school science subjects and to increasing their self-confidence in science.

Measures should be introduced to promote the participation of cities and the local community in the renewal of science education in collaborative actions at the European level aimed at accelerating the pace of change through the sharing of know-how.

The articulation between national activities and those funded at the European level must be improved and opportunities should be created for enhanced support through the instruments of the Framework Programme and the programmes in the area of education and culture for initiatives such as Pollen and Sinus-Transfer. The necessary level of support offered under the Science in Society (SIS) part of the Seventh Framework Programme for Research and Technological Development is estimated to be around 60 million Euros over the next 6 years.

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11 *http://www.pollen-europa.net/?page=CLDGDJVwskY%3D*
12 *http://www.sinus-transfer.eu*

A European Science Education Advisory Board involving representatives of all stakeholders, should be established and supported by the European Commission within the Science in Society framework.

In 2006 the **Math, Science and Technology Peer Learning Cluster**[13] was created, which was composed of 13 countries (CY, DE, DK, FR, IS, LV, MT, NL, NO, PT, SE, SK and UK) and had the aims of following the European MST benchmark and to improve participation in MST studies and careers, especially of women. The Rocard report is mentioned in the list of the Cluster objectives:

- Follow-up on the European benchmark on number of graduates and gender imbalance in MST;
- Increase participation in MST studies and careers, as well as women in science;
- Improve the scientific culture of citizens;
- Promote exchange of good practices and peer learning in MST;
- Follow-up of MST as one out of the eight key competences for LLL;
- Contribute to the preparation of scientific specialists needed for the goal of 3% GDP in research;
- Follow-up of FP7 'Science in Society'' - Rocard report, Women & Science.

Following the main findings and recommendations of the Rocard report, the European Commission decided to fund projects promoting innovative methods in science education. The **Seventh Framework Programme**[14] expanded the budget dedicated to the Science & Society Action from the 88 million euro allocated by the Sixth Framework Programme to the 330 million euro committed in the period 2007-2013.

The second action line of the **Science in Society Work Programme**[15]**,** titled "**potential and broadening horizons with respect to issues of gender and science education"** as a twofold objective: a) To boost gender equality in research, through stimulating the participation of women in science and technological development; and fostering the integration of the gender dimension throughout European Research and b) To contribute to the Lisbon Agenda by increasing the number of young people from all backgrounds entering careers in science, research and technology and, by raising the general level of scientific literacy, to increase awareness of the societal impact of science. Recently funded projects within this action line, promoting the IBSE methods across Europe, are: FIBONACCI[16], PRIMAS[17]; ESTABLISH[18]; S_TEAM[19] and SCIENTIX.[20]

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[13] *http://www.kslll.net/peerlearningclusters/clusterDetails.cfm?id=12*
[14] *http://cordis.europa.eu/fp7/home_en.html*
[15] *http://cordis.europa.eu/fp7/sis/home_en.html*
[16] European Commission, 2011 - Science, Economy and Society Highlights 2010
http://www.fibonacci-project.eu
[17] *http://www.primas-project.eu*
[18] *http://www.establish-fp7.eu*
[19] *http://www.ntnu.no/s-team*

Thanks to the efforts made and the actions undertaken at European level and by Member States **the benchmark of increasing the number of MST graduates by 2010 has been achieved and even doubled with a growth of 37, 2% registered in 2008.** This excellent result, nevertheless, is counter-balanced by a slower growth of the female share from 2000 from 30.7% to 32.6% in 2008. The gender gap remains significant in MTS, with men outnumbering women among MST graduates. Awareness of this must remain high: not only is there a risk of stagnation in numbers of graduates in MST but the number of researchers within the total labour force is still lower in the EU than in the USA and Japan. Additionally: the number of graduates has grown in some fields (such as computing) but not in others (such as life science and physics), and the gender imbalance in science studies and careers still needs to be reduced[21].

The **Agenda New Skills for New Jobs**[22], published in 2008 by the Commission, represents "A European Contribution towards full employment". **The communication reaffirms the development of basic competences such as literacy, numeracy and science as an essential element for inclusion, employment and growth but also highlights a shortage of qualified professionals in areas critical for innovation, such as Science Technology Engineering Mathematics.** The need of more investments to increase the number of graduates in science, technology, engineering and maths (STEM), so as to create the right conditions to deploy key enabling technologies, is envisaged as essential in the R&D and innovation strategies of industry and services in the near future.

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[20] *http://scientix.eu ftp://ftp.cordis.europa.eu/pub/fp7/ssh/docs/annual-report-ssh-sis-2010_en.pdf*

[21] European Commission, 2009 "Progress towards the Lisbon objectives in education and training - 2009"- *http://ec.europa.eu/education/lifelong-learning-policy/doc/report09/report_en.pdf*

[22] European Commission, 2008 - Communication from the Commission New Skills for New Jobs Anticipating and matching labour market and skills needs *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0868:FIN:EN:PDF*

In 2009 the **Strategic Framework for European Cooperation in Education and Training ("ET 2020")** was launched by EU Member States and the European Commission as a follow-up to the previous Education and Training 2010 work programme. The new framework addresses the following strategic objectives:

- Making lifelong learning and mobility a reality;
- Improving the quality and efficiency of education and training;
- Promoting equity, social cohesion and active citizenship;
- Enhancing creativity and innovation, including entrepreneurship, at all levels of education and training.

Among the new benchmarks set up for 2020 there is the **reduction of the share of 15-years old with insufficient abilities in reading, mathematics and science to less than 15%**[23]. This target will be reached by developing existing cooperation to improve the take-up of maths and science at higher levels of education and training and strengthening science teaching. The assessment of future skill requirements and the matching of labour market needs should also be adequately taken on board in education and training planning processes, with reference to the Communication "New Skills for New Jobs"[24].

Initiatives and projects described in the present report have been selected through a wide survey aimed at identifying good practices carried out at national and European levels in response to the policy orientation set forward by the outlined policy framework.

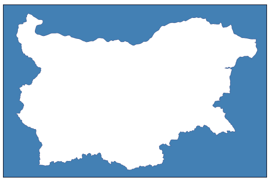
[23] *http://ec.europa.eu/education/lifelong-learning-policy/doc28_en.htm*

[24] Council conclusions of 12 May 2009 on a strategic framework for European cooperation in education and training *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2009:119:0002:0010:EN:PDF*

1 SCIENCE EDUCATION WITHIN THE EDUCATIONAL SYSTEMS IN EUROPE

Outlined here below is the dimension of science education within the greater context of educational policy frameworks for the STENCIL partner countries, those being: Bulgaria, France, Germany, Greece, Italy, Malta, Portugal, Slovenia and Turkey. Full national reports are available upon request from the STENCIL coordinating institution.

1.1 BULGARIA



The Bulgaria School Autonomy reforms began in 1998 with the delegation of some financial decisions to schools, but the most sweeping reforms began in 2007 with school directors being given authority over a wide range of school decisions and policies as well as a unified per student cost standard and delegated budgets. As a result, PISA 2006 provides a baseline measure of student achievement. The recent release of PISA 2009 provides student achievement data to examine how learning achievement has evolved since the reform.

There has been a significant increase in math and reading achievement since 2006. While Bulgaria had witnessed a decline in PISA achievement from 2000 to 2006, this trend has reversed.

PISA 2009 results show that in reading Bulgaria's score rose by 27 points since 2006. In absolute terms this score ranks Bulgaria 46th among the 74 participating countries. However, in terms of improvement, Bulgaria ranks 7th. While EU countries on average made no progress since 2006, Bulgaria improved its score significantly in math.

As a part of the fundamental education, science subjects learning in Bulgarian schools starts in the primary school and continues in the secondary school. According to learners some of the most frequently faced difficulties in science 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 provide for experiments to be conducted and does not contribute to better comprehension of the subject.

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

Most of the secondary school teachers share similar opinions concerning difficulties in the acquisition 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;
- no willingness and motivation to study;
- lack of specialized literature written in language which is easy to understand for students;
- insufficient training courses for teachers related to the interactive methods of teaching.
- young people are poorly motivated to learn science after secondary school.

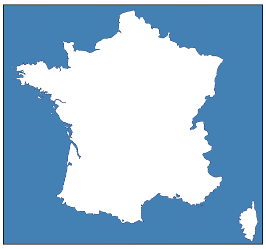
Interest in science learning has been plummeting for a long time and is rooted in the changes in society, organization of the learning process and the method of teaching in primary and secondary schools.

Specific policies proposed and adopted regarding science teaching are:

National Program for Development of Education, Science and youth policies in Bulgaria for the next 4 years that aims at achieving high quality of education, ensuring equal access to education and opening up the education system, incentives for 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, which are targeted at students from all secondary schools in Bulgaria aim at verifying the quality of education in scientific subjects. They create a strong link between knowledge and its application.

1.2 FRANCE



The renewal of science education started in France in 1996 with the “Hands on science” initiative (“La main à la pâte”). At the initiative of Georges Charpak, Nobel Prize in Physics in 1992, Pierre Léna and Yves Quéré and the Academy of Sciences, “La main à la pâte” aims to upgrade the teaching of science and technology in primary schools promoting teaching based on inquiry-based learning. In September 1996, a first experiment was implemented by the Ministry of National Education with the collaboration of the Academy of Sciences in five “départments”. It concerned 350 classes.

This inquiry-based learning approach was integrated in 2000 in the PRESTE (renovation plan for the teaching of science and technology in primary school). This renovation was a sustainable shift in teaching practices in the model initiated by the Hands on science initiative. The plan to renovate the teaching of science and technology takes into account the views expressed by teachers in the recent consultation of teachers on the documents of curriculum implementation. The pedagogical approach that it induces is based on questioning and investigation, constituting the scientific disciplines. Such an approach applies to content of current and future science curricula.

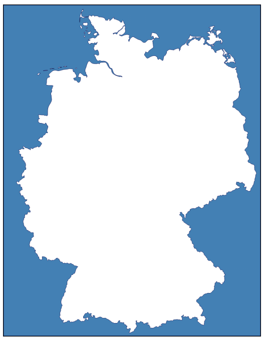
In 2005, the guidance Law called "common core of knowledge and skills" (“socle commun de connaissances et de competences”) introduced what every pupil should know and master at the end of compulsory schooling. It is all the knowledge, skills, values and attitudes needed to succeed in school, in life and as future individual citizens. In mathematics, based on the numeracy and elements of geometry, pupils learn to raise arguments that solve problems. Regarding the scientific and technological culture, pupils are introduced to the process of investigation and learn to act in a sustainable development perspective. The curriculum in primary and lower secondary schools includes this common core.

Recently, in 2011, the Minister of National Education reaffirmed the importance given to the investigative approach to science plan.

Despite the low PISA ranking of France, several initiatives are organised. The most famous national level initiatives are the ASTEP (Supporting teachers through the involvement of scientists in primary education) and the EIST (Integrated teaching of science and technology). “Supporting teachers through the involvement of scientists in primary education” (ASTEP) is one of the initiatives managed at the national level with support from the Academy of Sciences, in addition to various teaching methods already implemented in primary schools, to facilitate the teaching of science and technology consistent with the curricula and to give pupils the means to achieve the knowledge and skills defined by the common core. A national steering group holds regular national conferences and seminars to support the deployment of the initiative in the different academies (text adapted from the Ministry website).

Within the frame of a partnership between the Academy of Sciences, the Academy of Technology and the Ministry of National Education, the Ministry provides additional financial funding linked to the deployment of the EIST. It consists in proposing to students (11-13 years old) a unique experience in sciences and technology. A team composed of three teachers is constituted: one in Biology, one in Technology and one in Physics-Chemistry. They elaborate together pedagogical activities and have one hour in their agenda dedicated to common cooperation. The EIST meets the objectives of the common core of knowledge and skills: it is consistent with national programs.

1.3 Germany



The educational system of the Federal Republic of Germany corresponds to the federal structure of the State. Responsibility for educational legislation as well as administration lies within the *Länder*, the regional authorities and the lower-level school supervisory authorities. The *Länder* co-operate with each other within the framework of the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany on matters of importance for all Länder. The responsibilities of the Federal Government in education are defined by the Basic Law.

Particular attention is being placed on the enhancement of the educational level in the entire Federal Republic of Germany. On 22 October 2008, the Federal Chancellor and the Minister-Presidents of the *Länder* met at a Qualification Summit in Dresden to set the course for future education policy in Germany. They agreed on a comprehensive program to improve the quality of education in Germany in general from early childhood to advanced training. The program is titled: “GETTING AHEAD THROUGH EDUCATION - The Qualification Initiative for Germany” (Qualifizierungsinitiative für Deutschland). The Qualification Initiative led to the formulation of a set of guiding principles and a catalogue of measures to ensure education became a top priority in Germany. Concerning the field of science teaching, Guiding Principle #6 states: “More people should be filled with enthusiasm for scientific and technical vocations”. Background for that target is the fact that Germany relies on technical innovations as a strong part of the economy. As a gap of skilled personnel is expected to come soon, it is widely acknowledged by politicians and economists that Germany needs more people with qualifications in the so-called MINT subjects (MINT being the widely used German acronym for the science subjects Mathematics, Informatics, Natural Sciences and Technology).

Particularly over the last 5 years hundreds of initiatives in science education have been implemented on national and regional levels. They address pupils of all ages in all fields of sciences and also pay particular attention to the promotion of women. Thanks to the initiatives implemented, in PISA science tests pupils’ competences in Literacy, Mathematics and Sciences have continuously improved. Results from the 2009 survey are significantly above the OECD average. In particular the

achievements in Sciences have improved clearly since the first PISA survey in the year 2000.

1.4 Greece

The Greek educational system is highly centralized, although recent measures have been taken to devolve responsibilities to the regional level. The Ministry of Education formulates and implements legislation, administers the budget, coordinates and supervises its decentralized Services, approves primary and secondary school curricula and appoints teaching staff. In the past decade a series of reform and policy initiatives were introduced in an effort to improve the operation of schools and education offered, ranging from Curriculum Framework (adopting an integrated philosophy and reflecting an inter-disciplinary approach to knowledge) to teaching methods and materials to be provided to students. Particular attention is being paid to Science, Technology and Mathematics abilities. Regarding science courses the new analytic programme of studies is placed within the interdisciplinary and flexible educational framework by introducing new teaching methods that allow pupils to develop hands-on learning experiences, and projects and activities that emphasize the representation of simple scientific modules for the description of natural phenomena. Yet this orientation is still more at the level of policy than in the everyday school life.

Studies and evaluation reports investigating the efficiency of science education in Greek schools point to several areas of concern. The first and most important issue that should be addressed is the *inefficiency of the Greek educational system to implement the proposed reforms*. Although several reforms have been introduced they have often failed to make a real impact on the quality and efficiency of the system and to produce major global results as far as the performance of students and the achievement of learning objectives are concerned. New laws have often been enacted but not fully implemented.

Another issue that has been reported as acting negatively on pupil's understanding and performance is that the Greek educational system *allows for different scientific subjects to be taught by professors who are not necessarily specialized in the subject area*. For instance, a physicist may be also teaching chemistry. This phenomenon is observed more frequently in small schools located in isolated areas.

Hands-on science activities in primary education are not very common and therefore pupils are not trained adequately to evolve their skills and knowledge on science subjects. Since science activities are very important for primary education, they should be included in the primary teachers' practice, as they can help children to overcome their difficulties in understanding science concepts to a certain degree. The *poor connection of science education to the life experiences* of pupils is apparent also in upper secondary education which negatively affects their understanding of these subjects.

The improvement of science education is an important goal yet to be achieved in Greece as it has become evident that as it happens in most countries the Greek educational system still lags behind on this matter.

A few remarks on the Greek educational system

E. N. Economou, Professor of Physics, Univ. of Crete

Having a limited and fragmentary exposition to the primary and secondary educational system in Greece and an extensive experience with the higher educational system there, I think that I have identified a few key weaknesses which are of rather general character:

1. Too much emphasis on passive memorization (often of not so relevant points) and very little effort to set the student wondering and thinking over the provided information.

   As Richard Feynman put it “you may know the name of a bird in twenty languages and know nothing about the bird”.

   To try to set the student to a state of intellectual alertness and to “exploit” his natural curiosity for at least some subjects is not an easy task. But it is worth pursuing in a systematic and innovative way.

2. Too much is taught, too little is absorbed.

   Stephen Hawking in the foreword of his book “A short history of time” writes that his editor told him that every single equation in his book will reduce its readership by 50%. This is an amazing statement: It implies that, after six years of teaching algebra in high school, the end result is that the sight of a simple equation may scare the average educated reader to such an extent as to make the book inaccessible to him. What is a possible solution to this problem?

   I think that we ought to rethink the curriculum all over; possibly, we may reduce the number and/or the size of the obligatory courses, while investing more effort in them, and expand the number and/or the size of elective courses.

3. To face problems (1) and (2) above, talented and dedicated teachers are needed. To attract and have such teachers, a reliable evaluation system recognizing and rewarding the quality of their work must be set up.
4. In Greece and in other countries, where entrance to the Universities is achieved through national exams in a limited number of subjects, many high school courses not included in the national exams list are neglected. At the same time a private tutoring business has emerged for the courses included in the national exams. This distortion of the high school education is aggravated by the Universities being unable, as centrally controlled public institutions, to find realistic and innovative solutions as to strengthen the high school education without compromising the chances of a student to pursue his/her University studies in his/her favored field.

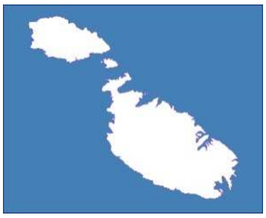
1.5 ITALY

In 2010 the Ministry of Education created a **Committee for the development of scientific and technological culture** which inherited the results of the previous Working group set up in 2006, with the aims, among others, to define actions for the diffusion of scientific and technological culture and to propose projects addressing schools, universities and teachers. In its introductory document, the Committee emphasizes the importance of a **global approach to the development of the scientific and technological culture**, with all actors (school, universities, authorities, associations, enterprises, media, etc.) working together in a network. At a school level, the application of the scientific method should be fostered and the use of laboratories encouraged. The cooperation School & University as well School & Science Museums is considered a key factor for the improvement of the teacher training and for enriching school education. Over the past decade **the Ministry of Education has promoted, in cooperation with teachers associations,** several national **projects on science education**. In the direction of creating a link between school, university and industry, is the **Progetto Nazionale Lauree Scientifiche**[25] launched in 2004 by the Ministry of Education, the Association of Italian Industry and the National Committee of Academic Deans of Science Faculties, in order to increase the recruitment in science universities (mathematics, physics and chemistry). The Piano **M@tlabel**[26] was launched in 2006 (then enriched thanks to EU structural funds) in cooperation with the Italian Mathematical Union (U.M.I) and Italian Statistical Society (S.I.S) in response to the worrying results of PISA 2003 with the aim to improve maths teaching in the lower secondary and first years of upper secondary schools. The plan promotes a continuous teacher training in a blended learning and collaborative approach and proposes activities that focus on 3 key aspects of maths learning and teaching: specific maths contents; "real life" situations that can stimulate pupils to learn; processes that pupils should activate to link problems with maths contents. Another important initiative was adopted by the Ministry in 2005/6 to promote innovation in science education: the **Piano Insegnare Scienze Sperimentali** (Teaching Science Experimental Model plan - *www.lfns.it/PianoISS*). The Plan is promoted by teachers professional associations such as the National Association for physics teaching (AIF), National Association of natural science teachers (ANISN), Italian Chemistry Society / Didactic Division (DD/SCI) together with the National Museum of Science and Technology Leonardo Da Vinci and Fondazione Idis Città della Scienza. The plan, which addresses primary and secondary schools teachers, aims a) at promoting an active role of the teachers in the training and self-training processes and in evaluation of teaching models and materials; b) creating local communities of practices for continuous and in-service teacher training offering informal and formal training opportunities in science education with the support of schools, universities and science museums. Thanks to the initiatives implemented, in PISA 2009 Italy improved the students performance

[25] Science Degrees Project/Plan - *htt35p://www.progettolaureescientifiche.eu*
[26] *http://www.indire.it/content/index.php?action=read&id=1439*

in Maths and Scientific literacy, from Level 2 to Level 3: but the average scores are still statistically significantly below the OECD average.

1.6 MALTA



Education in Malta falls under the responsibility of **the Ministry of Education, Employment and the Family** (MEFF). With the new reform that has been done to the Maltese education, schools have been grouped into College Networks. Each of these colleges is headed by a College Principal and is composed of a number of feeder primary schools and at least two secondary schools. There are a total of 9 schools together with 4 special schools.

State education is provided free of charge and the students are aged from 5-16 years. They are also provided with free textbooks and school transport. The education is divided in the following sections: Pre-Primary Education (not-compulsory), primary level and secondary level (compulsory). After secondary education, one can find a number of educational institutions that they can attend to as post-compulsory education. Apart from state schools, in Malta one can find a number of independent schools, the majority of which are Church Schools.

In 1988 The Malta Council for Science and Technology was established. Its main aim is to advise the government on Science and Technology policies together with other responsibility. They act as the national focal point for science and technology policy.

A number of policies have been proposed in a document called "**A Vision for Science Education in Malta 2011"**. The vision about science education is highlighted and also it was outlined that science education needs to be accompanied by a shift in the pedagogical processes used in the science classroom. Included in this report are suggestions to engage students and develop the ability to learn from one another.

Malta participated in TIMSS for the first time in 2007. From this survey some concerns arose. Malta ranked in the 30th place amongst 49 countries.

From an education point of views related to teacher training, this takes place at the University of Malta. Prospective teachers follow a Bachelors of Education Honours degree course. Teachers who would like to teach at a pre-primary level follow a diploma course at MCAST, the same goes for teachers who would like to teach in special schools.

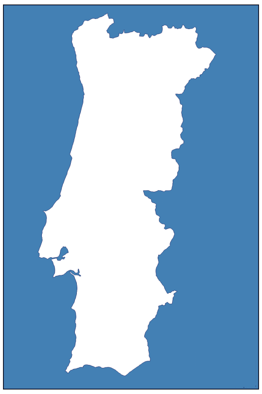
Pre-service teacher education and training is given from primary, secondary, upper secondary and post secondary education teachers.

All state school teachers are obliged to attend an annual compulsory 3 day in-service course organized by the Educational Officers or by the College Principal or by the Head of School. Such courses help to develop skills and attitudes, as well as create awareness about innovative pedagogical initiatives for the teachers.

Teacher preparation and training for science teachers falls under the responsibility of the Faculty of education. A future physical sciences teacher needs to have an

Advanced Certificate in Physics before he/she can start the university course. The selection of teachers are done by the Directorate for Educational Services by an annual call, teachers need to meet the qualifications required.

1.7 Portugal



Portugal has defined its scientific and technological development as a national priority.

Since 2004 the programme of the Portuguese government has included as one of its main features a technological Plan for the advancement of science, technology and innovation.

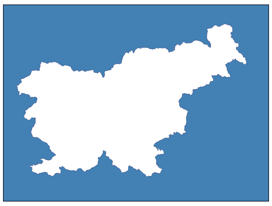
The goals require the renovation and expansion of the social basis for scientific and technological development in Portugal. This calls upon strong conviction not only from the scientific and technical professions and of public and private research organizations, but also from students and from the general population.

The Ministry of Education also decided to continue with a programme for continuous professional development for Mathematic first and second cycle teachers, in partnership with Higher Education Institutions with responsibility in the initial teachers training and first cycle schools and school clusters.

Other changes were recently introduced in the education sector in the scope of two major key concepts: the knowledge-based economy and the information society, and the fostering and consolidation of dynamics of change through a new perspective of the role of schools as a central point for building up knowledge, know-how, competency, new attitudes and interests. The Plano Tecnológico da Educação (Technological Plan for Education – PTE) intends to place Portugal among the five most advanced European countries in terms of school technological modernisation. Also within PTE, other projects were created with the aim to promote partnerships between educational institutions and enterprises. The priority given to the rapid scientific and technological development of Portugal has been matched by a profound reform of higher education, which reflects the current European movement to modernise higher education and, in particular, research universities.

Two initiatives can be considered good practices: National Competitions of Mathematics, Biology, Physics and Portuguese Language (PmatE), which main goal is to increase the interest and success in Maths, Biology, Physics and Portuguese Language; and Home of Science (Casa das Ciências) that is a portal of the Calouste Gulbenkian Foundation that aims to be a space of reference for science teachers.

1.8 Slovenia



In the Slovenian National Report on Science Education specific policies proposed and adopted regarding science teaching are described. In 2010/11, the Bologna reformed teacher training programmes were implemented. Moreover, the modernised programmes introduced new subjects concerning lifelong learning and inclusive education. In June 2010, the newly established National Agency for Quality Assurance in HE in Slovenia, abolished the regulations concerning teacher training programmes. From now on, the content of teachers' education is in the total autonomy of universities.

Furthermore the relative position of Slovenia in PISA 2009 is described. While the overall performance in mathematics and in science are above OECD average, the main concern is relatively poor performance in reading. What is worrying is that the results compared to 2006 have deteriorated significantly.

Regarding the prevailing didactical approaches and teaching practices used in Science Education, it is difficult to identify them as they somewhat vary from school to school according to teacher’s preferences and motivation. In general though, there is a lot of frontal teaching. Other didactical approaches are applied only sporadically.

In the report three initiatives in science education that have wide recognition are described. The first one is called “Science to Youth”. It is an infrastructural programme that includes the maintenance of infrastructure as support for research activities in the field of popularisation and promotion of science, encouraging youth and the elderly to learn science and offering support for encouraging youth to study natural and technical science, conducting training for science teachers, organising competitions in view of promoting knowledge and science. The second initiative is the “Young researchers for the development of Šaleška valley”. It encourages youth to do research, to be creative and innovative, to expand their knowledge, to develop critical and creative thinking. Through this initiative they are introducing science to the younger generation. The third initiative is the “Program to support technology development and information society for the period 2007-2012”. The program relates to the higher education level, especially MA and PhD studies since it includes the action title Young researchers in the industry/economic sector in order to stimulate the transfer of knowledge from the academic sector into industry, also stimulating students to take up science and technology studies.

In general, Slovenia shares the concerns that are related to the decline in young people’s interest for key science studies and mathematics, especially regarding in relation to the proportion of females of all MST graduates and students (which is 25%). These concerns are raised regularly in the public arena and are followed by the national initiative to improve the existing state of affairs and conjoined projects.

1.9 TURKEY

More than 90% of activity in formal education is provided by state organizations. There are also private education institutions. They follow the same regulations as state organizations. Private higher education institutions are subject to the same regulations although they are regarded as autonomous. The ministry of education is responsible for the preparation of curriculum and the buildings of educational institutions. Training activities in each city are organized by the director of national education who is assigned by the minister. Pre-school education comprises the children aged between 36-72 months and it is optional. Primary school education is compulsory for the children who are between 6-14 years. Private education is optional. In primary schools, a school term lasts 180 working days. Since 2006-2007 the curriculum in primary education has been updated. The course which was called "science" in those years has been re-named "science and technology". On the other hand, the course which was called "iş eğitimi" is changed as "technology design course" in which students make new designs with the information they learn in their maths or sciences and technology courses.

Turkey's Target In Education: There are several ongoing projects to achieve all these goals.

- Universalization of preschool education.
- Strengthening of relations between vocational education and labour markets.
- Development of a vocational qualification system related to vocational standards.
- Providing diversity on the basis of curriculum in secondary education.
- Development of a competitive higher education system through specialization, autonomy and academic freedom.
- Parity in schooling based on region and gender.
- Highly centralized structure of higher education system; accountability and administrative and financial autonomy in higher education. Reform studies in the field of education on the accession of Turkey to EU can be taken into consideration inline with Lisbon process and Bologna process.
- Constant increase in resources of government budget and households allocated for education since 2004.
- Reaching an achievement ratio close to the OECD average in education of mathematics, science and technology.
- Achieving a slight increase in the ratio of population graduated from secondary education, which falls too far behind the EU average.
- Aiming to make progress within 8 key qualification fields via a new primary education curriculum.
- Considering lifelong learning as a priority.
- Considering efficient and extensive use of information and communication technologies (ICT) as a priority.

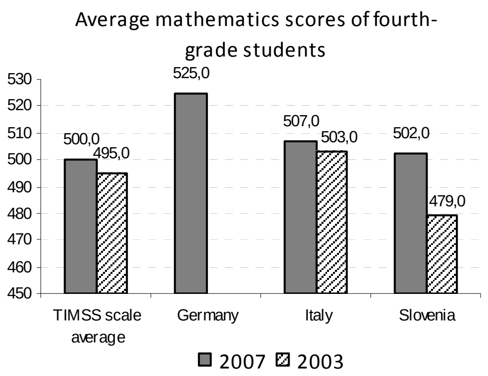
2. Performance of the STENCIL partner countries in international studies (TIMMS, PISA): A comparative perspective focusing on STEM

In order to develop a wider view of the relative average national performance in maths and science, the TIMSS and PISA assessment results are presented in the paragraphs that follow.

The Trends in International Mathematics and Science Study (TIMSS) is an international assessment of the mathematics and science knowledge of fourth- and eighth-grade (Year 5 and Year 9) students around the world. TIMSS was developed by the International Association for the Evaluation of Educational Achievement (IEA) to allow participating nations to compare students' educational achievement across borders. TIMSS was first administered in 1995, and every 4 years thereafter. In our analysis we included the two latest rounds, 2003 and 2007. Not all Stencil countries have participated in the 2003 and 2007 TIMSS assessment rounds. In particular Slovenia and Italy participated in the assessments of the 4th and 8th graders in both mathematics and science in both latest TIMMS rounds. Bulgaria participated in both rounds but only at the 8th graders level. Malta and Turkey participated only in the 2007 round and only at the 8th graders level. Finally, Germany participated only in the 2007 round and only at the 4th graders level (see charts 1 to 4 below). Therefore, caution should be used in cross-country comparisons.

Regarding the average performance of 4th graders in mathematics and science Germany clearly stands out for the excellent performance of its students in the 2007 TIMSS round. In both subject areas Germany’s performance is well above the TIMSS scale average. Italy’s 4th grade students are slightly above the TIMSS mathematics scale average but excel in science with an average score well above the TIMSS science scale average. Finally, Slovenia’s 4th graders exhibited remarkable progress in their average performance in both mathematics and science between the 2003 and 2007 rounds, particularly in science.

Chart 1 & Chart 2: Average national mathematics scores of 4th and 8th grade students in the 2007 and 2003 TIMSS rounds



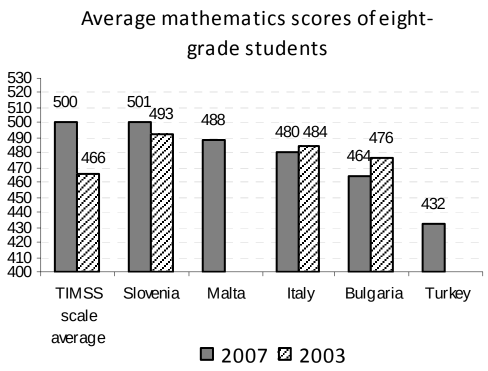
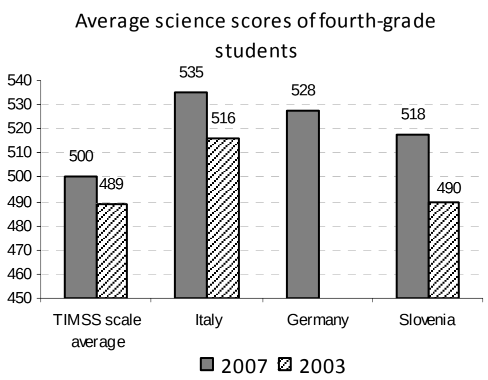
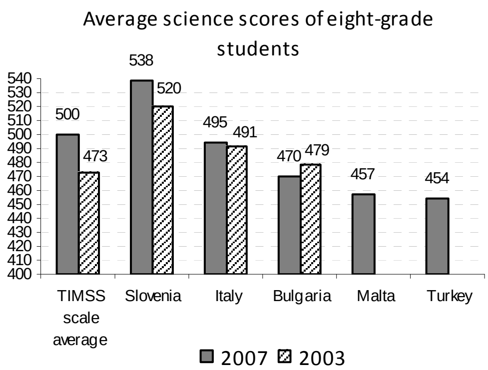


Chart 3 & Chart 4: Average national science scores of 4th and 8th grade students in the 2007 and 2003 TIMSS rounds





In the group of 8th grade students it is clearly Slovenia that exhibits the highest average performance in mathematics and science among the participating STENCIL countries. It is also worth noting that Slovenia's 8th graders perform well above the TIMSS average in science and that no other STENCIL country scored above the 2007 TIMSS average scores. This finding is alarming for Bulgaria given that in the 2003 round its average score in both maths and science was above the TIMSS average. Turkey performed well below the 2007 TIMSS average in both maths and science and Malta in science.

Germany and Slovenia also stand out for the above-average performance of their 15 year olds in the 2009 PISA mathematics and science assessments (see charts 5 & 6 below). PISA (Programme for International Student Assessment) is an international study which began in the year 2000. It aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students in reading, maths and science in participating countries/economies.

Chart 5: Mean country performance in the mathematics PISA 2009 assessments

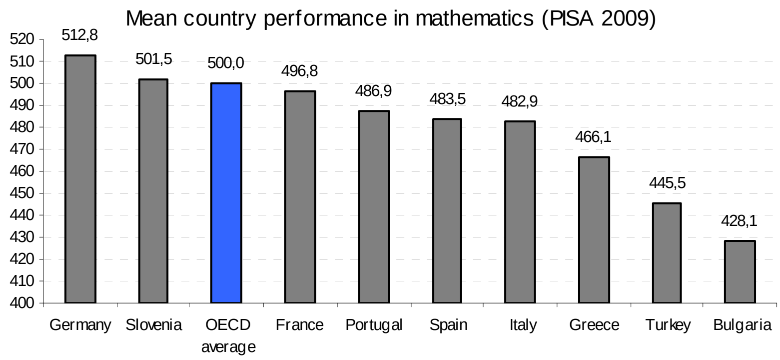
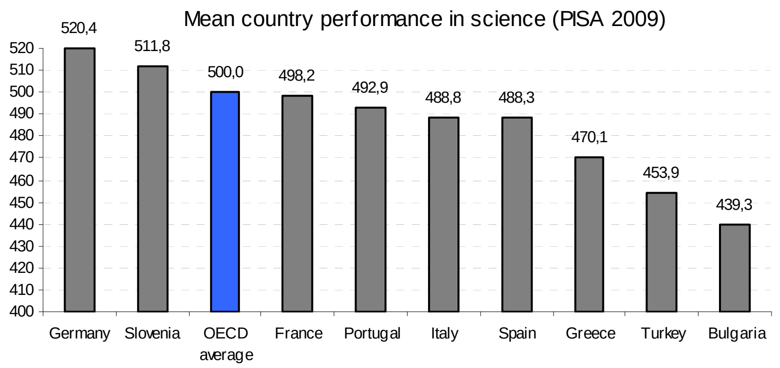


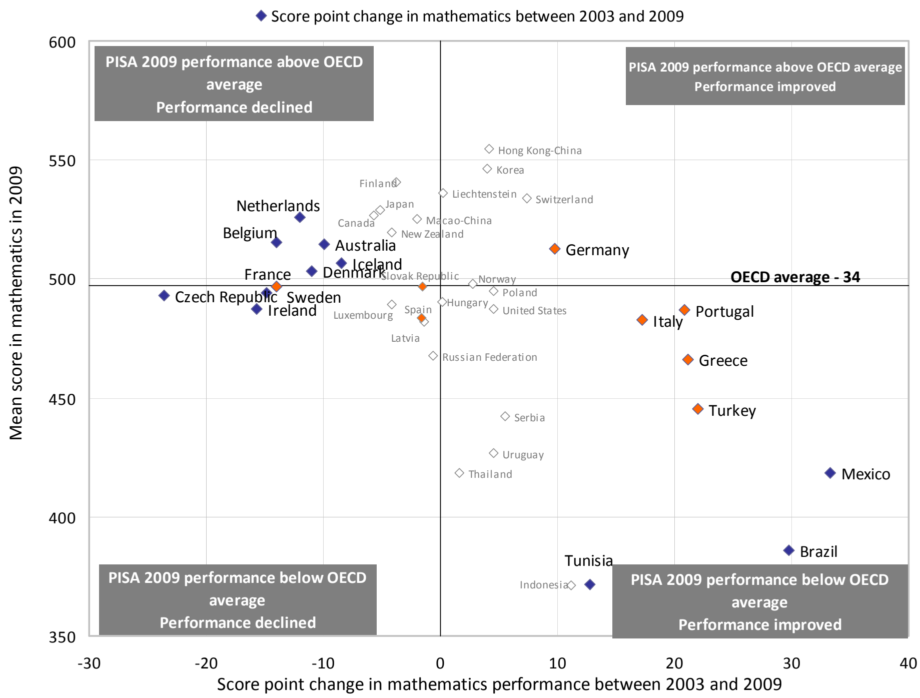
Chart 6: Mean country performance in the mathematics PISA 2009 assessments



In both maths and science the average performance of France's 15 year olds does not statistically differ from the OECD average. On the other hand, all other STENCIL countries participating in the 2009 PISA round performed statistically below the

OECD average. Indicative is also the relative country progress in average performance between PISA rounds. As shown on the chart below (upper right quadrant), the performance of Germany's 15 year olds in mathematics is not only higher than the OECD average but also improved as compared to the 2003 round. The 2009 mathematics average performance of Italy, Portugal, Greece and Turkey also is statistically higher than this of the 2003 round.

Chart 7: How countries perform in mathematics and how mathematics performance has changed since 2003

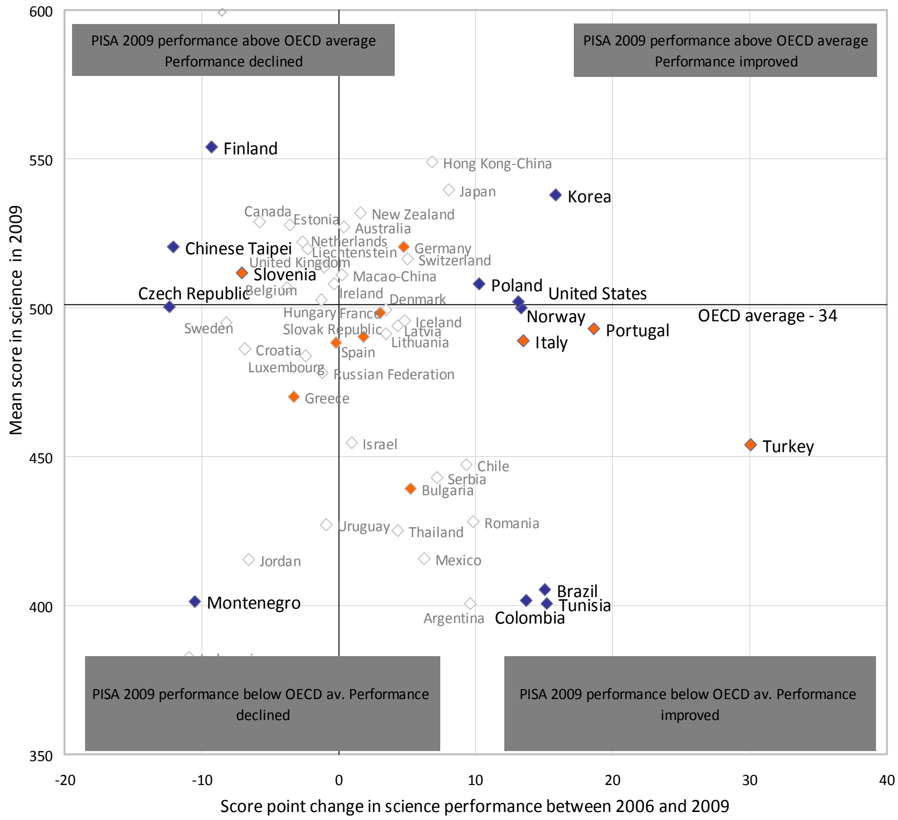


Note: Score point changes in mathematics between 2003 and 2009 that are statistically significant are marked in a darker tone

Source: OECD PISA 2009 database, Table V.3.1

Regarding average performance in science between the 2009 and 2006 PISA rounds, Slovenia's average performance declined but still remains above the OECD average (see upper left quadrant on the chart below). Similarly to the mathematics performance, there was a statistically significant improvement in science performance among 15 year olds in Italy, Portugal and Turkey.

Chart 8: How countries perform in science and how science performance has changed since 2006



Note: Score point changes in science performance between 2006 and 2009 that are statistically significant are marked in a darker shade

Source: OECD PISA 2009 database, Table V.3.4

Overall, the TIMSS and PISA results examined above show that among the STENCIL countries the student populations of Germany and Slovenia appear to be performing above average in maths and science. Comparatively, the student populations in Bulgaria and Turkey are on average less well performing in maths and science.

3 TEACHER TRAINING POLICIES

How do member states prepare and upgrade skills, competencies, attitudes and knowledge for science teachers; education? It is now widely recognized that the quality of education is greatly influenced by the quality of teachers and their skills. The benefits of establishing policy cooperation with European Union partners to address common challenges in improving education has been acknowledged by member states. Therefore, although differences in teacher training policies exist across member states, the quality of education and training, and with it the quality of Teacher Education, are high on the policy agenda in all the countries of the European Union.

Teacher training is a lifelong process that should expand beyond the initial academic teacher education to constantly develop new skills and competences and expose teachers to innovative teaching tools and pedagogical theories. The world is constantly changing and pupils' understanding and learning skills are greatly influenced by new technologies. Teachers should keep up with the rhythms of change in order to successfully address educational goals.

Generally speaking, lifelong teacher training is divided in three stages. The first stage concerns the initial academic education of teachers, where they master the basic knowledge and skills of their time. The second stage concerns the first independent steps as teachers, which are usually accompanied with challenges and confrontations with the realities in schools and classrooms. This phase is generally called the *induction* phase. The third phase concerns the continuing professional development of those teachers that have overcome the initial challenges of becoming a teacher. All teachers will go through those phases. However, the quality

of their progress will depend strongly on the support that is available to them in each of those phases.

The issue of support of teachers in their induction phase was less considered in teacher training programmes. However, it is of particular concern in a context of teaching skills shortages and, in some countries, of large numbers of young teachers leaving the profession because of lack of support and motivation. The European Commission Communication 'Improving the Quality of Teacher Education' noted that, where they exist, support measures for new teachers are still relatively unsystematic and emerging rather than well embedded. In the policy paper, Teacher Education in Europe (2008), ETUCE advocates that an induction phase of at least one year's duration should be both a right and an obligation for newly qualified teachers and involve systematic guidance and support.

For the newly qualified teachers, the induction phase must include[27]:

- support from mentors and other colleagues
- a reduced teaching timetable without a decrease in remuneration
- access to appropriate support resources
- attending a mandatory guidance programme
- opportunities to relate theory to practice in a systematic way

As expected, support for teachers during the induction phase in Europe varies. Induction is generally regarded as a type of support programme for new entrants to the teaching profession and its official definitions vary. The data listed below to describe the situation in Europe regarding these issues are taken from a 2010 Commission Report[28]:

In some countries, induction is aimed at new teachers who have completed initial teacher education, have attained the relevant qualification (a degree), and have obtained the relevant licence or permission to teach.

In other countries, induction is aimed at teachers who have the required qualification but not yet a licence to teach; in these cases, they are regarded as 'candidate' or 'probationary' teachers or 'trainees' and the induction phase may end with a formal assessment of their teaching skills and a decision about their entry into the profession.

In other countries, induction is aimed at teachers who are not yet qualified and do not have a license to teach; in such cases the division between initial teacher education and induction becomes blurred.

Finally, in the majority of European countries, there is no state-wide system of induction as such.

The induction phase generally lasts between ten months and two years. In Greece, Spain, Italy and Cyprus, teachers have to follow compulsory training during their probationary period, the length of which varies widely. Compulsory training for new

[27] *http://etuce.homestead.com/Publications2008/ETUCE_PolicyPaper_en_web.pdf*
[28] *http://ec.europa.eu/education/school-education/doc/handbook0410_en.pdf*

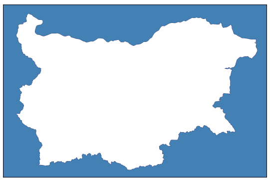
entrants also exists in France, Liechtenstein and Turkey. Of the countries that organise an induction phase in one form or another, some provide it for teachers who work at pre-primary, primary, general lower and upper secondary levels of education, whilst others provide it only for teachers at secondary levels; some provide it for work at primary, but not at pre-primary level. During induction, new entrants carry out wholly or partially the tasks incumbent on experienced teachers, and are remunerated for their activity. Most countries provide this 'induction phase' in addition to the compulsory professional training received before the acquisition of a teaching diploma. Although only a few countries offer coherent system-wide induction programmes, many offer, on demand, some separate support measures for new teachers that can help them to overcome difficulties they may experience as newcomers to the profession, and reduce the likelihood of their leaving the profession early.

In section 3.1 a brief insight of the teacher training practices in the STENCIL partner countries is provided. As it becomes evident, differences exist in both the organisation and content of support services and teacher training programs. However, the importance of lifelong learning and supportive measures during the induction phase of teachers is more or less recognized.

REFERENCES: *"Developing Coherent and system-wide induction programmes for beginning teachers: A handbook for policy makers "(European Commission, 2010)* *http://ec.europa.eu/education/school-education/doc/handbook0410_en.pdf*,
"*Teacher Education in Europe" (ETUCE, 2008)*
http://etuce.homestead.com/Publications2008/ETUCE_PolicyPaper_en_web.pdf,
"Improving the quality of teacher education" (European Commission, 2007), *http://ec.europa.eu/education/com392_en.pdf*

3.1 Teacher training practices in the STENCIL partner countries

3.1.1 Bulgaria



A total of 13 universities have faculties of education and they are the most popular place of teacher training. In addition, there are 12 teacher colleges which belong to universities' structures. College graduates usually continue their studies in part-time short-term programmes at universities' faculties or departments of education for obtaining Master's degrees.

Teacher's professional qualification can be obtained in two models, the *concurrent* and the *consecutive*. In the *concurrent* model, students pursue their academic subjects –such as mathematics, history- in the relevant faculty of the university, and those who decide to become teachers, take in the same time additional courses in the Faculty of Education. In the *consecutive* model, the teaching qualification is acquired after graduating the major speciality: those who are willing can enrol in a qualification course to become teachers either immediately after graduation or after some time.

The qualification course to become a teacher, in either of the two models mentioned above, includes both theoretical education and practical training under predefined unified educational minimum requirements. Students are expected to do about 120 hours of teaching practice in schools. The practical training, during which students must deliver personally between 10 and 22 lessons, shall be provided in forms and academic hour allocations.

As the pre-service education for teachers in Bulgaria, *in-service teachers' training* is part of the higher education system and is regulated by the Higher Education Act. In-service teachers' training is offered both on a regular basis for personal and professional development, as well as on an *ad hoc* basis for training teachers on new policy developments, such as the introduction of new National Education Standards, new curriculum requirements, external evaluation of students' achievement, introduction of information technologies, and so on. Regarding the continuous training on a regular basis, different units provide this training: universities, teachers' associations, trade unions, NGOs, training centres established by international programmes (e.g. EC-Phare, Tempus), regional inspectorates of the MES, etc. Only the Departments for Information and Teacher Training though located in Sofia, Varna and Stara Zagora, respectively associated with the Sofia, Shoumen and the Trakian Universities (but with juridical autonomy) provide officially recognised training that may promote teachers' careers. [1]

Teachers in Bulgaria attend in-service training courses for two main reasons: to achieve attestation and accreditation to advance their careers, and to upgrade their skills and keep abreast of new curricular and teaching developments. These are the findings of a pilot survey conducted in 2004-05 within the parameters of the project "Teacher Qualification Models for Education Reform Implementation" addressed to

304 teachers coming from different types of schools and having a wide range of professional experience (Balkan Society for Pedagogy and Education, 2006). The need for professional skills improvement is indicated as the principle motive for attending in-service training (50.32% of the interviewees) followed by the career development (40.64% of the interviewees). Only a 7.74% of the interviewees associated in-service training to higher remuneration. Nevertheless, bearing in mind that attending training for career advancement (responded by the 40.64%) also implies increases in salary, we may deduce that teachers in Bulgaria participate in continuous training motivated equally for their personal development as well as for better working and salary conditions.

In-service training is progressively increasing in quality and diversity in Bulgaria. New courses are being developed gradually to support new policy developments in the Bulgarian education system, as well as to catch up with recent European trends, giving emphasis on innovative teaching approaches, computers applied in pedagogy and interactive teaching-learning processes.

In the field of teachers' qualification, during the years 2005-2007 an analysis of the teachers' working environment was performed. 1 000 instructors in basic computer skills were trained. 95 000 teachers have acquired basic computer skills out of 108 569 in total, while the training of the others is still ongoing. Over 2 000 IT teachers for 5th grade have been trained. The introduction of the new subjects 'Information Technologies' and 'Man and Nature' has been supported by organizing trainings of those teachers, who work with 5th-grade students. To this purpose, 2 617 teachers obtained additional qualification in teaching Man and Nature, Physics, Chemistry and Biology. [2]

The National Institute for Training of Head Teachers -- which recently took over considerable functions for teacher qualification - has been operational for four years now. In its work with head teachers, the institute offers courses and seminars specialized for kindergarten head teachers, newly appointed head teachers, school principals, resource centre directors, head teacher applicants.

Teachers in all subjects, incl. Physics can be retrained at any university with a pedagogical specialty. The country has three specialized departments for the teachers' improvement - in Sofia, Stara Zagora and Varna. There is also a National Pedagogical Centre with branches in all regions of the country, where different courses for maintaining teachers' qualification are organized. All teachers in the country went through mandatory courses on ICT. As a result of the project "ICT in Education" Ministry of Education provided free internet access to all teachers for 12 months and created an educational portal where teachers can be trained (free of charge) in English, computer skills and other key competencies[29].

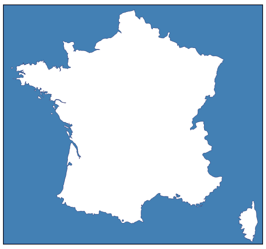
Training of teachers on project development and management is conducted by different organizations against payment. The country can still do a lot in this direction. Since 2007 the Ministry of Education organized a national contest "The school – a wanted area for students" for collecting good practices in three areas -

[29] *http://internet.mon.bg*

Pedagogical innovative methods and technologies for the formation of key competences; Civil education, extracurricular and club activities, prevention of aggression and violence in schools; Innovative approaches for school management. The competition is held at four levels - school, municipal, regional and national, as best practices are published in a collection[30]. Finally, the Ministry of Education has developed training programs for teachers, some of which are above mentioned activities.[31]

References: *[1] Dr. Irene Psifidou, Training Teachers In Bulgaria: Changing Learning Paradigms, "International Handbook on Teacher Education Worldwide: Issues and Challenges for Teacher Profession". p.97-122, Volume I. K.G karras-C.C Wolhuter (eds) Atrapos editions. 2010. [2] National system overviews on education systems in Europe and ongoing reforms, 2010 Edition, EC*

3.1.2 France



Teacher training in France was reviewed in depth in September 2010. It is now necessary to obtain a Master's degree to be selected via the competitive examination for teacher placement. The students then become full-time trainees for a year and are tenured after being inspected. Obviously the vast majority of teachers have benefited from the previous training system. They were recruited through competitive examinations open to candidates with a Licence 3 degree. Candidates could enter a one-year training programme in an IUFM (French teachers training institutions) to prepare for the exam. Once the exam was passed, the "Professeurs des écoles" (primary teachers)-in-training were given general and vocational training in their second year at the IUFM, after which they received the professional degree earning them the title of "Professeur des école"s. Citizens of the European Union who met the necessary conditions might be admitted to the category "Professeurs des écoles" under the same terms as French citizens.

There are about 530,000 teachers in secondary schools. Previously, students with a License 3 degree could prepare at the university for the competitive examination. The certification could be obtained only after admission to the examination and a one-year paid internship consisting of 8 hours per week and 2 days of training in the training institution. Since this school year, teachers have obtained a Master 2 degree in a specific discipline. They pass the competition during the second year of the master. In the case of success, they become trainees during the following year and are full-time tenured after being inspected.

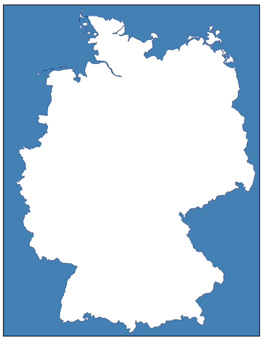
The in-service teacher training aims to provide teachers with professional skills necessary for constant adjustment to the changes of the educational system and to support pupils. The academic (regional) training plans are produced locally in a perspective of closely accompanying teachers and teams. National priorities for

[30] e.g. *http://www.minedu.government.bg/opencms/export/sites/mon/left_menu/projects/unesco/sbornik-dobri-praktiki.pdf*

[31] *www.strategy.bg/FileHandler.ashx?fileId=1492*

teacher training are enumerated according to the specificities of the academy. The teaching staff is divided roughly into a small fraction motivated to use all opportunities, institutional or other, and a large fraction that does not participate in any institutional training. Indeed, according to the 2006 survey DEPP 65% of teachers - averaged across all disciplines - do not participate in in-service training throughout their careers; except mandatory training in primary schools, the same participating teachers are often identified each year in the offered training.

3.1.3 Germany



The responsibility for teacher training rests with the Ministries of Education and Cultural Affairs of the Länder. They regulate training through 'training regulations' and 'examination regulations'. The basic entry for teacher training courses is the higher education entrance qualification (*Hochschulreife)*, which is acquired after attending school for 13 years and passing the *Abitur* examination.

Teacher training then is divided into two stages starting with a course of higher education, followed by practical pedagogic training in school settings called 'preparatory service'. Training for primary school teachers takes 3.5 years at university. Lower secondary teachers would study 3.5-4.5 years followed by 2 further years of preparatory service. For upper secondary school teachers, training takes 4.5 years at university, then a 1.5-2 years practical training is conducted in a school setting. Performance of teachers is examined by two examination rounds (First and Second Staatsprüfung), which are conducted by the state examination authorities or boards of the Länder.

Following successful completion of their preparatory service, newly-qualified teachers are ready for permanent employment at public-sector schools. The decision on recruitment is made centrally in each Land on the basis of job vacancies and according to the criteria of aptitude, qualifications and record of achievement. Successful applicants are usually appointed as civil servants on probation. During the probationary period, which for teachers has a duration of 2.5 years (higher service) or three years (senior service), a teacher's aptitude and performance are monitored with regard to his future appointment as a permanent civil servant. Salaried teachers have a six-month probationary period.

In-service training - like initial training – is the responsibility of the Länder. In each of the Länder the Ministry of Education and Cultural Affairs is responsible for in-service teacher training because it is the highest school supervisory authority and usually the employer of teachers. State-run in-service teacher training is organised at central, regional and local level. In-service training can also take place within schools or in the form of guided private study.

Usually teachers for secondary schools study two subjects and have a low proportion of pedagogical training. The proportion of the subject matter is about 40% in relation to the study of the subjects (Master / Diploma).

At present it is also possible to have 'lateral entry' into the job of a teacher. That means: 100% study of the subjects, for example, in Physics, approval for Mathematics, no pedagogical training. Lateral entry can happen directly into school or via preparatory service.

There are no special trainings for teachers. They attend the basic lectures in Physics (Experimental Physics and a limited choice of Theoretical Physics). Additionally they complete a basic and advanced practical training.

Advanced training is offered, at times controlled, via a points-based system. But the assigned points are rarely checked. Advanced training in ICT is offered on a more voluntary basis, the more as the technical equipment/infrastructure at schools only has become sufficient recently.

Increasingly, student research centres are set up by universities, and there are also offers for school classes and teachers (laboratories, etc). But these offers are mainly directed at pupils and rather serve to ease the workload for teachers than as stimulation and activation.

3.1.4 Greece

Teacher training in Greece follows a "concurrent" education model which combines pedagogical and practical training. However, pedagogical training was not available in the curriculum structure of secondary teachers in the past. Their initial training remained largely focused to the subject of their specialization, without any systematic pedagogical training. However, new educational reforms have started to change this pattern in order to ensure that all teachers are training in basic and up-to-date pedagogical methodologies and techniques. This problem is almost reversed as far as primary education is concerned. Although teaching science is one of the main objectives for primary teachers, many seem to ignore it and put more emphasis on other subjects because they often do not have the requisite subject matter knowledge, and they don't feel very comfortable with science.

Pre-primary and primary school teachers are degree (*Ptychio*) holders from a four-year university-level course, primarily from Pedagogic Schools. The education of the primary school teachers is provided at the Pedagogical Departments of Primary School Teachers established at the Greek Universities. Lower and upper secondary education teachers hold university degrees in their specialization subject after completing a four-year course and take a three-month introductory teacher training course upon appointment. Access to all teaching posts in the state sector (pre-primary to secondary level) is determined by competitive examinations administered by Supreme Council for Civil Personnel Selection (ASEP). It should be noted that appointed science secondary school teachers are graduates from Physics, Chemistry, Biology and Geology departments as well as Engineers. Teachers' further education is divided into induction for newly appointed persons and periodic for those already working and takes place at the Regional Further Education Centres (PEK). Continuous training takes the form of additional education programmes, which, upon their approval by the Minister of Education, Lifelong Learning and

Religious Affairs are implemented by specialized education bodies. In order to accomplish its purpose, the Organisation for the Further Education of Teachers (OPEK) co-operates with the Pedagogical Institute (PI), the Centre for Educational Research (KEE), public services and organisations, Greek and foreign Universities, Technological Education Institutions (TEI) and research centres.

Forms of obligatory further education include periodic further education for permanent teachers which consist of special short-term further education programmes (half or full term) for all teachers and for those serving in Special Education units. Teaching staff is selected for periodical further education from lists drawn up by the Regional Directorates. In determining the order of precedence, the following are taken into account: the teachers' need for further education, the operational needs of schools, the teachers' seniority, and other possible needs. The curriculum and practical exercises, as well as the total number of teaching hours are laid down in Presidential Decrees or Ministerial Decisions. Teaching at Regional Further Education Centres (PEK) is carried out according to contemporary methods and techniques, such as: lectures, seminars, tutorials, workshops, presentations and study, research and practical exercises, incorporating all manners of instruction that elicit active participation in all phases and activities of the educative process. Teaching aids and modern teaching technology are used extensively in further education courses. A certificate is granted to all those who successfully complete further education programmes. Upon completion of the further education programme, teachers return to their schools.

The objective of these programs is to inform newly appointed teachers or those already working, on developments in the science of teaching and on new teaching and assessment methods and to develop their skills in order to enable them to adapt to the constantly changing conditions of education and perform their work more effectively. More specifically, in the framework of Community Support Framework III and the Operational Programme for Education and Initial Vocational Training (EPEAEK) II the following project was carried out: "Intensive Teacher training on contemporary teaching approaches and methods for the development of critical and creative thinking": The project's objective was to instruct, inform and raise awareness in 6,000 teachers of all specialties, from both Primary and Secondary Education on modern teaching approaches. In parallel, teacher training courses in new Information and Communication Technology (ICT) have already taken place and will continue to be staged in the future.

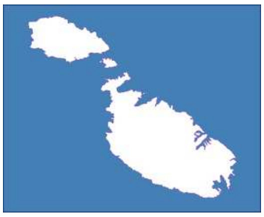
The further education programme "Environmental Education" has been put together in cooperation with the Training Institute (INEP) of the National Centre for Public Administration and Local Government, whilst at the same time proposals have been submitted for further training in Environmental Education for 5 categories of Primary and Secondary education teachers.

Finally, the programme "Utilising the Internet for Environmental Education - Open and Distance Learning" is being carried out in collaboration with the Centre for Educational Research (KEE). The Programme is for Primary and Secondary Education

teachers, who are interested in becoming involved in implementing Environmental Education programmes and activities and teaching on environmental issues.

REFERENCE: *"Organisation of the education system in Greece 2009/2010" http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/eurybase_full_reports/EL_EN.pdf*

3.1.5 MALTA



Teacher training in Malta is the responsibility of the Faculty of Education. A future physical sciences teacher needs to have an Advanced Certificate in Physics before he/she can start the university course. During the university course, the student-teacher attends the physical sciences lectures with the Bachelor of Science (Physics) students for the physical science content. He/She then learns about the pedagogy of the subject by lecturers in the Faculty of Education. Moreover the student-teacher gets three (six-week) teaching practice sessions during the course, in which he/she practices the pedagogical aspects of the physical science in the classroom. He/She is supported and assessed by the lecturers at the Faculty of Education. The Directorate for Educational Services (DES) issues an annual call for new teachers (around May) in state schools, in the Government Gazette (*http://www.doi.gov.mt/EN/gazetteonline/2011/05/gazts/GG%2017.5.pdf*) pg 5526). The qualifications are various 4.5.1 - 4.5.7, however what is minimally required is a B.Ed (Hons) specializing in physical sciences or a First Degree and a PGCE with physical sciences as the main area of study. A Public Service Commission selection board interviews the candidates and recommends a priority listing by which candidates should be employed with the state. The Human Resource Department within DES posts teachers to the various state schools according to the results of the interviews.

Each Church school and Independent school constitutes its own selection board to choose teachers. The minimal qualifications required are identical to those of state schools. These selection boards work independently of each other and of the state schools.

For Primary Education teachers: The Faculty of Education within the University of Malta is responsible for pre-service teacher education and training at primary education level. Students intending to become primary school teachers follow a four-year concurrent course to acquire a Bachelor of Education (Honours) degree (ISCED 5A).

For Secondary Education teachers: The concurrent model consists of a four-year course leading to a Bachelor of Education (Honours) ISCED 5A or a consecutive three-year course leading to a B.A./B.Sc. degree in subject content plus one-year professional training course leading to the Post Graduate Certificate in Education model. Training takes place at the University of Malta. Sixty-eight percent (68%) of the B.Ed. (Hons) course focuses on professional training while 28% of the course is devoted to the core content.

For Upper Secondary and Post-Secondary Education teachers: Teachers at these levels of education are called assistant lecturers, lecturers and senior lecturers depending on their qualifications and length of service. Lecturing staff at this level are all graduates and postgraduates many of which hold Doctorate degrees. Those who teach in institutions for which the Education Division is responsible have to be in possession of pre-service training.

A teacher appointed to teach physical sciences in a state school can only teach physical science or integrated science. He/She cannot teach Biology or Chemistry, unless he is qualified in these sciences and has passed the selection boards' interviews for Biology or Chemistry.

In Church and Independent schools, a physical science teacher may be asked to teach Biology, Chemistry and/or Integrated Science as required by the particular school.

All state school teachers are obliged to attend an annual compulsory 3 day in-service course organized by the Educational Officers or by the College Principal or by the Head of School. Such courses help to develop skills and attitudes, as well as create awareness about innovative pedagogical initiatives for the teachers. Such courses usually take place at the end of the scholastic year (July) or at the beginning of the scholastic year (September). Other voluntary courses are organized by various organizations and teachers may opt to attend them if they are not called for a compulsory course.

During the school year, schools organize regular Continuing Professional Development sessions for teachers. Such sessions include different type of training such as session in the use of ICT in the classroom, teaching in a differentiated environment, meeting the challenges of students with special needs, etc. Such professional training is compulsory, but teachers may seek further optional training both at government agencies or private.

There is no formal structure to support teachers' initiatives to be involved in projects, etc. However all such participation is highly encouraged, especially by the Education Officers for the subjects. Participation in European/International competitions are suggested and supported as much as possible. (*http://physics.skola.edu.mt/upcoming-events/u4energy-competition-2010*) The Maltese Association of Science Educators (http://*www.masemalta.com*) also encourages such participation and has in the past organized 'good practice' activities itself. It also publishes a cyclical newsletter 'Sci-News', together with the Directorate for Quality and Standards in Education, which gives publicity to innovative work and good practice taking place in the science laboratories. Also, the Faculty of Education together with DQSE organize an annual science education seminar in which students of Masters degrees exhibit their dissertation work to the public.

3.1.6 ITALY

For a long period a degree was not required to become a primary school teacher in Italy, but a specific high school diploma (Istituto magistrale) was sufficient. Only "starting from 1990 an university course was established and required for primary school teaching qualification, named Sciences of Primary Education. The new training is spread over four years, courses covering both content subject matter and methodological studies and a large amount of practical training at school. (…) Specific classes are devoted to mathematical and scientific content subject matter and didactics. The scientific area is mainly focused on physics and biology, with some coverage of environmental themes"32.

Secondary school teachers must hold a Laurea magistrale. Lauree Magistrali permit admission to one or more of the teaching qualification classes following official tables issued by the Ministry of Education. Until 2007/08, after the Laurea, it was necessary to complete a 2-year specialisation course at the Specialisation school for teaching at secondary level (scuola di specializzazione per l'insegnamento secondario, SSIS).

Initial teacher training has been reformed through a new regulation introduced in 2011, which is characterized by the following aspects:

- introduction of one-year practical training at school to be carried out after attainment of Laurea magistrale;
- planning of the number of new teachers according to the requirements, in order to prevent teachers' temporary employment. In accordance, admission to degree courses for prospective teachers will take place upon a selection based on the requirements of the national education system;
- specific degrees for teaching qualifications in the various subjects. Furthermore, initial teacher training won't be only focused on subjects skills but also on cross-curricular competencies like better mastery of English ICT for teaching and a better qualification for integration of disabled students.33

Among the initiatives promoted by the Ministry and carried out through the National Agency for the Development of School Autonomy (Agenzia nazionale per lo sviluppo dell'autonomia scolastica) and its peripheral offices, the PIANO SCUOLA DIGITALE is aimed at integrating new technologies in the teaching practice, including among the others initiatives to experiment in the daily teaching activities the use of ICT (Cl@ssi 2.0) and to equip schools with IWB and to train teachers on how to use it.

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[32] Italian Survey Report - TRACES: Transformative Research Activities. Cultural diversities and Education in Science. FP7 project n. 244898 - Coordinator of the project and author of Deliverable: University of Naples "Federico II - *http://traces.fisica.unina.it/* contact: *traces@fisica.unina.it*

[33] European Commission, Eurydice - National system overviews on education systems in Europe and ongoing reforms 2010.
http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/national_summary_sheets/047_IT_EN.pdf

The Agency also manage the FOR learning environment for the online in service teacher training and GOLD the online database of good practices realised in Italian schools of all levels.

3.1.7 Portugal

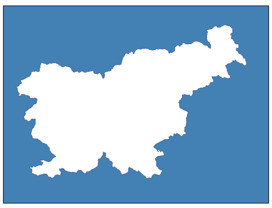
Initial training for pre-school teachers, and for ensino básico and upper secondary education teachers, includes a scientific and pedagogic component required to obtain a specific professional qualification. This is acquired by attending a higher education course leading to a licenciatura degree as laid down in Law No. 115/97, 19th of September, which altered the previous stipulations in Education Act No. 46/86, of 14th October. In line with a new wording of the Education Act in Law No. 49/05, 30th of August (Art. No. 34) "the training of pre-school education teachers and teachers of 1st, 2nd and 3rd cycles of ensino básico is done at colleges of higher education and universities."

Training for upper secondary education teachers is administered only in universities. The professional qualification for teachers of upper secondary education can also be acquired through licenciatura that provide scientific training in the respective area of teaching, complemented by appropriate teacher training. Decree-Law No. 344/89, 11th of October, undergoing changes due to the Bologna process, provides the legal backing for teacher training and defines the components of the different initial training courses, in which the number of teaching hours varies according to course type:

- Personal, social, cultural, scientific, technological, technical or artistic training;
- Educational sciences;

Teaching practice supervised by the training college, including different course activities and which, at the end of the course, may take the form of practical training.

3.1.8 Slovenia



The initial training of teachers is conducted by universities in the form prescribed by the higher education legislation and education regulations regarding requirements for teachers and other pedagogical workers. Teachers can obtain teaching qualifications in two ways:

Concurrent model or integrated model: initial training can be obtained by completing a teacher education study programme, thereby being awarded the professional title, *profesor,* of one or two subjects. The integrated model leads to the profession of a general teacher at the primary level or to a pre-school teacher in pre-primary settings.

Consecutive model: if the teacher completes a non-teaching study programme which provides appropriate knowledge in the subject of teaching but does not

provide professional training, the teacher must acquire such knowledge through a supplementary post-graduate course leading to a teaching qualification (e.g. courses on psychology for teachers, didactics, pedagogical science, anagogical science and special didactics). These regulations allow teachers who complete the teacher training study programme to acquire the knowledge of another similar subject through a supplementary post-graduate course in a new discipline. Class teachers in basic schools obtain their qualifications in study programmes based on the integrated model, whereas subject teachers in basic schools and teachers of general subjects in upper secondary schools usually follow the consecutive model. Prior to the Bologna reform, study programmes took four years to complete. After the Bologna reform, which is being implemented gradually from 2006 to 2009, study programmes in education will take five years (3+2 or 4+1), that is, 300 credit points. The Higher Education Act (2006) stipulates that the old academic study programmes (which took between four and six years) and the new Bologna programmes, which have a weighting of 300 credit points, are equal on the qualifications scale (level 7). Pedagogical modules will be in most cases implemented in the Bologna 2nd level (+2 or +1). Pedagogical study programmes are mainly offered by the three faculties of education, but also by some other faculties, such as the Faculty of Arts in Ljubljana and Maribor and the Faculty of Sport in Ljubljana. Some faculties, mainly those of sciences, provide pedagogical programmes in cooperation with faculties of education.

The teachers are appointed by individual schools (a headmaster or a principal have the main role in this process). The school announces a job opening. The best applicants with proper qualifications (the basic being education) are then invited for a job interview. The final decision is made by the school's principle.

In principle, a teacher can only teach subjects for which they have proper education/qualifications. However, there are cases where a teacher can teach a similar subject (e.g. physics can teach chemistry or biology), but only when the teacher does not have enough hours of teaching his/her own subject.

The goal of in-service training is professional development and the personal growth of pre-school teachers and teachers, and thereby improvements in the quality and efficiency of the educational process. Pre-school teachers and teachers are entitled to in-service training. A pre-school institution or school must provide study leave, with a minimum of five days per year or 15 days every three years, for in-service training and must also cover these expenses: salary compensation, any travel expenses, participation fee and accommodation costs. Programmes are run partly during the week; when this occurs the school administration finds a supplementary teacher. The rest of the programme is organised at weekends or on work-free days. Pre-school teachers and teachers choose, at their own discretion, the programmes and forms of in-service training. When training is required due to reforms or substantial changes in curricula, participation in the so called commissioned and priority programmes of in-service training is classed as compulsory or recommended. In-service training is encouraged and rewarded. Points are awarded for participation in specific programmes of in-service training and the acquired

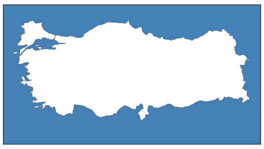
points are taken into account when considering the promotion of teachers and pre-school teachers. In-service training is, in fact, one of the pre-conditions for promotion.

The support system mainly consist of the support for teachers by the national education institute of the republic of Slovenia (Zavod RS za šolstvo; *http://www.zrss.si/default.asp?link=ang*) The National Education Institute is an important partner in the circles of all those who have been conceptualizing education and has undertaken a visible role in the processes of implementing and monitoring innovative programs and practices in kindergartens, schools and student dormitories. It provides experts support, counselling, workshops, the co-called update seminars, access to expert literature, evaluation, etc. Teachers are encouraged to take part in its activities. Since 2000, The National Education Institute is an important factor in the education system's restructuring process. Together with others it has devised new curriculum solutions, developed methods for the successful transfer of modifications into the education system and devised a plan for accompanying the curriculum or programs and new elements into practice. A great deal of additional education and training of professional staff at kindergartens and schools was necessary and will be necessary in the future as well. The Institute carries this out in the form of seminars, symposiums, specialized conferences and, most of all, through workshops and study meetings of teachers and other educators within the framework of a vast network of kindergartens and schools. The Institute is also strengthening its activities in the international framework as it desires to assert itself at the world level as a reputable professional institution in the area of education. It is associated with approximately 300 kindergartens, 450 primary and 160 secondary schools. It carries out more than 250 different seminars, which are attended by more than 12000 people. 20000 to 25000 educators and teachers cooperate within the mentor networks at kindergartens and schools including different educational conferences. It has more than 200 employees with more than 80% possessing higher education (amongst them 25% have their Masters or PhD.) Slovene educational network (*http://www.sio.si*) provides support to teachers in the field of eLearning.

The National Examinations Centre (http://www.ric.si) is a central institution established for the external assessment of pupils, apprentices, students and adults in Slovenia and it also assist teachers with evaluation activities. It supports the development of methodologies and procedures of assessment and certification of professional skills and abilities, issues licences, keeps records, and monitors the work of committees for the assessment and certification of national vocational qualifications. The Centre organises and provides education and training for external examinations and test paper preparation.

The publishing houses that publish school textbooks also provide support to teachers and employ experts in the field to carry out workshops.

3.1.9 TURKEY



Teacher training in Turkey is done in faculties of education. There are 67 faculties of education throughout the country and 46 of them have a science teaching program (for grades 6-8). In 1992 a separate science teaching program was established for middle grades because the science courses in these grades include all sorts of science topics. It was thought that when teachers certified in physics, chemistry, or biology teach these courses they were more inclined to give emphasis to their own areas and often omit others. Hence, it was deemed that there was a severe need for teachers certified to teach multiple science topics.

In Turkey the usual practice is that a classroom teacher takes a class from grade 1 and teaches them for 5 years until the end of grade 5. This places a large responsibility on classroom teachers as these general education teachers are responsible for the scientific education of their pupils. A resolution to this is being discussed is if it would be better to have science teachers teach 4th and 5th science courses instead of classroom teachers.

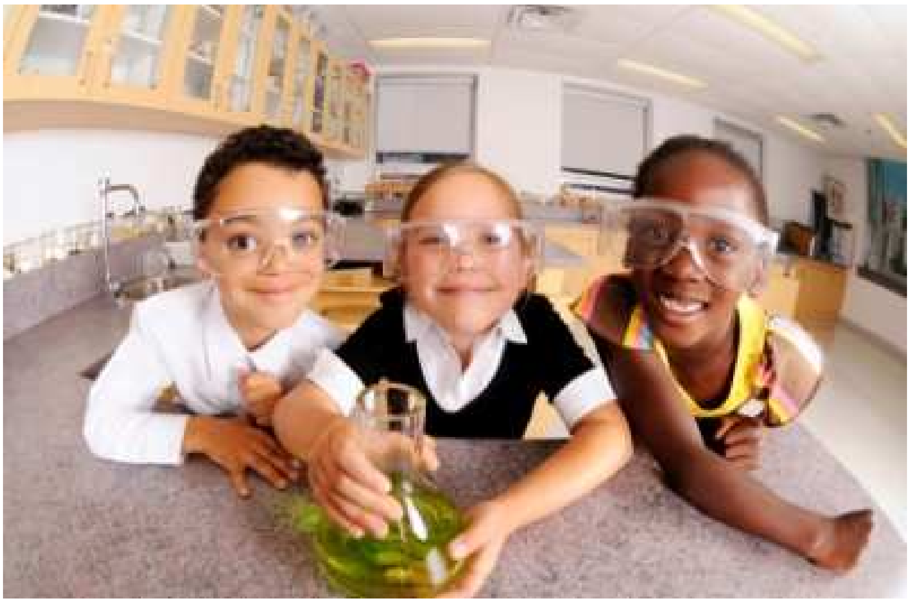
Prospective primary teachers attend 4-year university programs in Turkey. Prospective teachers of secondary education attend 5-year programs in faculties of education. Also, graduates of faculties of arts and sciences can attend a masters program (3 semesters) offered by faculties of education in order to become eligible for teaching. All the prospective teachers have to pass a qualifying exam before getting employed by the MNE. Although most universities have masters programs in education currently there are only 9 universities offering PhD degrees in science education in Turkey.

With the recent changes made in the curriculum, students may bring their daily life experiences into classrooms and, conversely, can take out their school experiences outside the school. In order to realize this, several suggested activities are provided in order to incorporate many related curricular outcomes to technological understanding. The new curriculum, where appropriate, prompts teachers to important student misconceptions identified in the literature. Another purpose is to alert teachers to those wide spread misconceptions since often times the teachers may have persistent misconceptions themselves. The new curriculum urges teachers and educators to use more formative learning assessment and measurement techniques rather than usual paper and pencil tests. Among the many alternative measurement methods and techniques that can be listed the range includes developing a student portfolio, group activities, and peer evaluation.

PART II.
INNOVATIVE EU PROJECTS

1 GOOD PRACTICES IN SCIENCE EDUCATION

The improvement of science education is an important goal yet to be achieved as it has become evident that most countries still lag behind on this matter. According to the *Rocard Report* (2007)[34] science education is far from attracting crowds and in many countries the trend is worsening. The research also suggests that the origins of this situation can be found, among other causes, in the way science is taught. The situation is even worse when it comes to gender, as research suggests that girls are less interested in science courses than boys. This observation, however, has to do again with the teaching methods and techniques employed than with anything else.



The concept of 'good practice' in the project refers to a set of actions that are expected to **improve the way science is taught and to increase the interest and**

[34] *Rocard, M. (2007). Science Education NOW : A renewed Pedagogy for the Future of Europe, European Commission, Directorate-General for Research, Information and Communication Unit. Brussels. Available at:* http://ec.europa.eu/research/science-society/document_library/pdf_06/report-Rocard-on-science-education_en.pdf *[Accessed 29/09/2011].*

knowledge of students. Special attention is put upon the **transferability** of such practices as it is desirable to make good practices applicable to as many settings as possible and to **include diversity and minority issues** in the ever-changing EU community. **Pedagogical practices** and **teaching methodologies** that have proven to be most effective in science teaching and learning, such as **inquiry-based** methods and **hands-on approaches**, are equally significant. Finally, the importance of developing an **efficient assessment plan** is stressed, as research has shown that although good practices are said to be adopted in institutions, in reality little is done to actually employ them. For instance, while most of the science education community agrees that IBSE (Inquiry Based Science Education) is the most efficient approach, in most European countries actual science teaching does not follow this approach. Therefore, it is important to ensure that good practices and recommendations will be employed.

In this context, STENCIL project has investigated a number of EU projects that are completed or still running that were deemed innovative in terms of the criteria set in the STENCIL grid (see annex 1). The following projects are registered in STENCIL database and the **European Catalogue of Science Education Initiatives,** which contains more than 900 initiatives realized in schools all over Europe, directly included online by teachers or educators who have planned or managed them. The projects presented in this book have been selected based on the criteria listed in the selection orientation grid for assessing STENCIL initiatives. Another important selection criterion was whether the website of each project was functioning efficiently and further publicized tangible tools and results of the project's objectives.

The selected projects demonstrated innovation, clarity in the provided documentation, relevance for practice and policy, sustainable results and covered important pedagogical methodological aspects of science education today. Each selected project focuses more or less on a specific category of the selection grid (i.e. teachers' education, teaching methodologies, equity considerations).

The selected projects were roughly categorized in 5 thematic areas (*teacher training in science education, collaborative approaches to science teaching learning, new pedagogical approaches, innovation in teaching and learning, science education as a mean for key competences development and science education for diversity*) and each is introduced with a contribution of an expert on this area. The selected projects more or less cover issues from all the thematic areas (for instance, a project can be equally valuable to teacher training and new pedagogical approaches); however, they were divided based on their strongest value and impact.

Presented here below are summaries of the selected projects and initiatives per thematic orientation and introduced by an expert contribution.

2 Teacher training in science education

CONTRIBUTION: MARIO BARAJAS, ANNA TRIFONOVA, DPT. OF DIDACTICS AND EDUCATIONAL ORGANISATION, UNIVERSITY OF BARCELONA, SPAIN

Why inquiry-based science education is failing in Europe? The view of the teachers.

There is a well recognised need to improve science education, enhancing scientific literacy and students' critical thinking skills, involving different learning environments (schools, universities, science centers) and recognising the diversity of personal learning styles and behaviours in different contexts and applications. But how do we reach these objectives? In most European countries, science teaching methods are essentially deductive. The presentation of concepts and intellectual frameworks come first and are followed by the search for operational consequences, while experiments are mainly used as illustrations. A change is under process in some countries towards more extensive use of inquiry-based methods however, the mainstream still remains mainly deductive (EU, 2007: 10).

An inquiry based approach to teaching is now widely advocated and is being implemented in many different countries across the globe since there is growing evidence that this has a positive influence on both performance and attitudes to science. Inquiry leads to understanding and makes provision for regular reflection on what has been learned, so that new ideas are seen to be developed from earlier ones. It also involves students working similar to the scientific procedures, developing their understanding by collecting and using evidence to propose and test their ways of explaining the phenomena. However, it is optimistic to assume that

change in pedagogy can be brought about without changing the content, the curriculum or the teaching culture.

Level of adoption of IBSE in Europe

What is the current situation in Europe? In order to weigh the level of adoption of IBSE in European schools, a series of workshops took place in 15 countries, under the umbrella of the project PATHWAY[35]. During 2011, a series of 38 Workshops were organised by PATHWAY in 13 European countries (including Russia), involving 1370 school teachers, 35 policy makers, 10 curriculum developers, and more than 400 teacher trainers, and other specialists in science education. The participants of the workshops were stimulated to share their own involvement in IBSE, including participation in IBSE activities, level of collaboration in innovative IBSE in which they are involved and familiarisation with IBSE methodologies and characteristics.

Curriculum constraints and opportunities for applying IBSE and the limitations of the school practices were a central theme in the Visionary workshops. Participants described practical limitations they foresee for applying Inquiry Learning in their schools/country and also suggested possible ways to overcome these difficulties.

In general, in most countries a low level of IBSE adoption was reported, although there are some exceptions, like Finland where IBSE is well incorporated into the teaching reality. Overall, teachers who implement IBSE activities are usually isolated cases. Often they feel alone, not supported by the curriculum, nor by the school and without collaboration with their colleagues.

In most workshops participants reported a series of constraints and barriers for the adoption of IBSE, varying from curricular limitations to incompatible school practices, from the lack of resources, time, and adequate training to lack of interest and curiosity by other teachers. Nevertheless, participants were generally enthusiastic and eager to find solutions to the identified issues, rather than to

[35] PATWHAY (The Pathway to Inquiry Based Science Teaching). FP7, Science in Society, THEME SiS-2010-2.2.1.1 (2011-2013). More information at *http://www.bayceer.uni-bayreuth.de/pathway/*

blame the circumstances for the impossibility of IBSE adoption. However IBSE is seen by teachers and trainers as an opportunity in many respects:

A variety of **collaboration opportunities** emerge in the process of IBSE uptake. Those between teachers of the same school and between schools in the same region or country are the most immediate ones. Such collaborations can help develop professional communities sharing ideas, materials and approaches more widely, benefitting all participants. Internal collaboration with experienced teachers is also expected. Collaboration with external partners, such as research centers, scientific institutions, university departments, observatories, astronomical centers, museums and field centers, is expected to be very beneficial. There is a special interest in local level collaboration, which allows visits and exchange. Research centers have programs to promote science and research in schools and society which is favorable for the process of adopting IBSE in schools. The organization of visits, talks, sharing resources/materials and also obtaining guidance from a "specialist" are all appreciated opportunities.

Communities of practice are necessary, that will facilitate the exchange of experiences, the promotion of IBSE activities, and the sharing of resources/materials between teachers and with these institutions. Strengthening the school-parent collaboration which includes family-oriented scientific activities is also seen as an opportunity that will permit wider IBSE acceptance.

IBSE also provides the opportunity for teachers to re-invigorate their teaching methodologies. Specific teacher training and personal development programs are essential and should include new educational trends and in-depth study of IBSE methodology, but also subject specific areas. **Teacher training** might take the form of action research and professional inquiry, as practicing the methodology themselves is a highly effective way of supporting teachers in promoting inquiry in their science teaching practice. Training should give teachers resources to facilitate the use of IBSE.

Currently, teachers find **opportunities for implementing IBSE** through a variety of activities, such as student projects, or research camps. They see themselves assisting students in doing research according to their own interests. Furthermore, science contests for children, developing and incorporating IBSE related awards and programs or other competitions are seen as a good means for stimulating IBSE adoption.

The creation of **new teaching resources** related to IBSE in all science subjects is a big opportunity for the successful uptake of IBSE. Resources should be relevant to the current curriculum. Teachers need case-studies of IBSE detailing the impact on students' learning along with the advice and the experiences of other IBSE practitioners. There is a rapid expansion of the repositories of science educational resources. Collaboration with external institutions for sharing resources and materials is also seen as important opportunity.

Challenges for IBSE adoption and proposed solutions

In general, it is believed that there is a need for improved quality of science education for all, both for future science graduates as well all students. Wider adoption of IBSE might be a way to address this, although there are many challenges that need to be met in order for successful, wide adoption to occur.

Key challenges were identified and solutions explored to overcome the difficulties they foresee for wide adoption of IBSE in their country's context. Several distinct strategies were proposed by teachers for solving the problems discussed:

Changes in the educational system and the organisation of educational activities

Changes in the educational organisation have been proposed within many workshops. As stated, one challenge identified by the Visionary workshops participants was the incompatibility between current school schedules and time required for inquiry activities. Participants propose to change the time and location of science lessons, thus allowing for longer sessions and blurring the boundaries between theory and practice. Furthermore, changes in the educational organization are needed to face the problem of the large number of students per group.

In some countries, there is room for different timetable models that could be implemented to create more time for teachers to both be more creative within the curriculum parameters and also to have some professional development time in the school year without impacting their scheduled classes. Furthermore, there is a need to explore different models for resource allocation and sharing within school regions.

Support from senior management

It is critical to get 'buy-in' and support from senior management teams in schools as this creates a school climate in which there is 'permission' to take risks with

classroom practice and explore new approaches to developing science knowledge. Some teachers also felt that they would need support from their head teachers/school principal or senior management team in order to be able to successfully apply IBSE strategies. Schools (not individual teachers) set targets and receive resources, thus the importance of involving the senior management. Having the support of a management figure such as a head of science was seen as critical to any shift in practice.

Coordination among teachers

One of the challenges in respect to the wide spread adoption of IBSE which has been identified is the lack of collaboration between teachers. Improving the communication flow between teachers and between the staff in their school in general is needed. If teachers shared experiences and resources, it would be easier to prepare and carry out IBSE activities, and it could also spread more easily.

Communication between teachers and textbook publishers

Regarding the textbooks, teachers suggested that the book editors take their opinions into account when designing books. This might allow inclusion of certain tested inquiry-based activities linked to the curriculum and thus wider adoption/acceptance of IBSE.

Filling the theory-practice gap

Teachers agreed that the separation between theory and practice should disappear in science education. However, they didn't agree on whether the space to use should be the classroom or the lab.

Production of ready-made IBSE packages

For teachers, existing resources could be utilised for IBSE. However, specifically designed resource banks and centres could assist teachers to find the appropriate

resource to use with the methodology and thereby save time for the teacher in implementing the scenario.

Providing teachers with case studies of IBSE in action, detailing the positive impact on students' learning and having the benefit of advice and hearing the experiences of other practitioners who are already teaching using IBSE methodologies will help teachers to feel more comfortable trying out a new approach. The challenge is to provide IBSE resources and experiments that meet the needs of mainstream teachers. These needs usually refer to the time and cost of the activity, and to the availability of resources, which are often perceived as sophisticated facilities. We should avoid the feeling of many teachers stating that "I can do the same, more easily, with less means".

New Professional Development IBSE support

Teacher training and support for developing IBSE classroom practice has been underlined as essential in the process of adoption of IBSE. Good teacher training is essential, especially that which puts the teacher in the shoes of the student/learner. This is recognised as a very effective way to help change one's teaching style and practice. Teachers are familiar with the concept of the initial challenging question but are probably less familiar with the notion of encouraging the students to develop their own research questions. Furthermore, whilst teachers are familiar with the role of facilitator, there is a tendency for teachers to use a directed approach to learning. Training on IBSE should address the above mentioned issues.

New ways of assessing science knowledge

With regards to assessment, it is necessary to explore new ways of assessing science knowledge. Assessment-based constraints placed on schools and teachers by an examination system that often seems to value subject knowledge/content above other aspects of science education may limit the impact of any attempts to incorporate IBSE practices in science teaching. New approaches are needed that will focus not only of facts and content, but also on the processes, skills, etc. In order to reconnect the testing process to the on-going classroom practice, it is important to build in a good self-evaluation process for students and work on other interim evaluation tools and methodologies.

Increase acceptance and support by the society

Some teachers pointed out that the main challenge is that IBSE is not seen/perceived by most of their colleagues, by parents and by other relevant actors as the 'correct' way to teach students and that it is too time-consuming. The prevalence in most countries of an exam-based culture leads to low acceptance of IBSE, including by teachers, parents and students, many of which expect and require traditional teaching methods and textbooks to be used. One group suggested that there is an expectation from students that the role of the teacher is to tell them what they need to know to in order to pass the exam so there may be some initial resistance from students to IBSE.

This type of thinking is very closely linked to the belief that learning can only ever be measured through exam results and the requisites of the university entrance. This belief is particularly strong the closer a student gets to nearing the completion of compulsory schooling and the last school year before university. Better communication about IBSE should be developed to show the advantages and results of the methodology.

Reference: EU (2007) Science education Now (The Rocard report). At *http://ec.europa.eu/research/science-society/document_library/pdf_06/report-Rocard-on-science-education_en.pdf*

2.1 Network „Teilchenwelt“ (particle world), Germany

Website: *http://www.teilchenwelt.de*

Link to the STENCIL catalogue entry:
http://www.stencil-science.eu/initiatives_view.php?id=998

The network „Teilchenwelt“ is funded by the Federal Ministry of Education and Research of the Federal Republic of Germany. Partner: the German Physical Society (GPS) as patron and CERN and the internet platform *www.weltderphysik.de* as partner. The project management is set up at TU Dresden. Furthermore the team consists of several people in different subprojects at different locations.

There are two target groups: students aged between 15 and 19 years and teachers at schools, student labs, student research centres, museum educators etc.

The main goals of the network are:

- to arouse fascination for basic questions about our universe
- authentic experiences with own measurements with original data
- to enable the experience of research
- to support individual reflection about scientific phenomena
- introduction of basic research as a cultural possession
- technical information for the public and multipliers (teachers) about particle physics and astroparticle physics
- education of young scientists in communication
- offer of study and career choice for young people

The „Teilchenwelt“ network basically addresses all interested students regardless of their choice of subjects. There are connecting factors especially in physics but also in interdisciplinary instruction “natural sciences”, which is taught in several German states. Furthermore, there are connecting factors in the technical and engineering fields but also in computer science. Therefore, especially technical full-time vocational schools benefit from this opportunity. In general, physicists and scientists participate in the opportunities offered for teachers.

The network „Teilchenwelt“ offers a **multi-level programme for young people and teachers which is based on one another.** There are different levels of specializations possible which range from events in individual schools to workshops at CERN and research projects at the institute. The basic programme is the heart of the network, especially the so-called Particle Physics Masterclasses. Additionally to the Particle Physics Masterclasses the network also offers experiments with cosmic particles. Here you can find the offers schematically:

Offer for teachers

Participation in

- teacher days at "International Masterclasses"
- other introductory events

Different methods will be applied depending on the specialization level.

Information and communication technologies are an essential part in the network „Teilchenwelt" as it is a nationwide network. On the one hand the network uses the internet via programmes used during the Masterclasses because all exercises are available for free on the internet and can therefore be repeated at home. During International Masterclasses the video conference tool "EVO" is used so that the students can exchange with each other. Especially the presentation of measurement results in experiments with cosmic particles by the participating students on the internet plays an important role. Furthermore a series of measurements, for instance the Trigger-Hodoscopes, can be evaluated by students through data that has been provided on the internet. On the other hand the network „Teilchenwelt" uses interactive tools like Facebook, an interactive forum on particle physics, and Twitter for communication.

In addition to creating and gathering of context material on the internet strongly multimedia-based offers to impart particle physics are made accessible. **The project aims for the increased and lasting cooperation with teachers.** Specialized projects, workshops etc. are possible which can be developed in cooperation with teachers. The development of supporting and context material is a step in this direction.

The increase of Masterclasses in schools is planned in the project plan from 40/80/120 in 2010/2011/2012. In 2011 already more than 50 Masterclasses have been carried out, therefore the high goal will probably be exceeded. But we see a further expandability in our activities regarding extracurricular learning locations. The cooperation with student labs and student research centres started right from the beginning, an increase is possible. The offers regarding experiments with cosmic particles will increase considerably within the next two years. At the moment the experiments are edited and enhanced at DESY in Zeuthen and will be disseminated at 15 locations nationwide, which will then offer projects with these experiments.

The creation of support and context materials about particle physics is under development and will bring a considerable development regarding the offer for

teachers. The network “Teilchenwelt” is going to be a key contact in Germany for teaching particle physics in instruction - in school or at extracurricular learning locations.

It is possible that the network „Teilchenwelt“ could be a model for other countries but at the moment no further European expansion stages are planned. However, the “sister project” of the network “Teilchenwelt”, the “Hands on Particle Physics Masterclasses” is already active in Europe. Because of numerous synergy effects cooperation will be fruitful in the new EU funded European project “Discover the Cosmos”. The teacher training for becoming a multiplier through teacher days a CERN workshops is effectively designed, because they will get technically and methodically able to make particle physics a part of their instruction.

2.2 INSPIRE - Inspire School Education by Non-formal Learning

Website: *http://www.inspire-project.eu*

Link to the STENCIL catalogue entry:
http://www.stencil-science.eu/initiatives_view.php?id=1070

Partnership

- Hamburg University of Applied Sciences (Germany)
- Förderverein NaturGut Ophoven e.V. (Germany)
- Daugavpils University (Latvia)
- Panstwowa Wyzsza Szkola Zawodowa W Raciborzu (Poland)

The EU-project *'Inspire School Education by Non-formal Learning'* (INSPIRE) fosters information and learning on renewable energy and climate change. The vision of the project INSPIRE is to improve the quality and attractiveness of **in-service teacher training** in an extracurricular context and by using new learning places. INSPIRE is a project funded by the European Commission´s Lifelong Learning Programme (2007) by means of the COMENIUS Multilateral Project's budget line.

The main objective of the INSPIRE project is to create synergies and links between extracurricular venues of education and curricular education, thus improving the base of knowledge of European students on matters related to education for sustainable development. In addition, it aims to prepare a set of materials that may support teacher training on renewable energy and climate issues, as well as test such materials with a view towards subsequent use in support of informal education.

INSPIRE's goals are therefore very much in line with the objectives of the UN Decade of Education for Sustainable Development. The project partnership in Germany, Latvia and Poland has developed approaches, methods and materials that may be used in other countries in Europe and beyond.

The main target groups of INSPIRE are **teacher training institutes, and non-formal education institutions such as museums and environment centers, etc**. It is expected that school teachers and education officers working in non-formal education outlets will access the new pedagogical methods developed as part of the project and use the practical information on teaching approaches developed here, which may optimize non-formal learning processes.

Each partner country (Germany, Latvia, Poland) created five innovative lesson units for extracurricular educational venues which can be integrated into the curricula of school education. The subjects are renewable energies and efficient energy use. The units support scientific education as well as environmental knowledge, social skills and the awareness of social responsibility.

The innovative learning modules on energy issues for extracurricular venues were developed to demonstrate non-formal learning and teaching methods, as it is the main goal of this project to give inspiration to teachers on how it could be possible through the use of didactical-methodical elements in extracurricular venues to achieve better learning results in school lessons. The learning units are designed in such a way that both extracurricular educational venues and teachers at school can use them, or the teachers can find an impetus for their own lessons.

The lesson units are developed for students ranging from 12 up to 18 years old with different durations of 6-8 hours up to 1-2 weeks of project work in groups.

The 15 lesson units on renewable energy and efficient energy use are available at: *http://www.inspire-project.eu/documents*

In-service training course for teachers

An in-service training course was developed that introduces teachers to the innovative utilization of extracurricular lessons on renewable energy and efficient energy use for the benefit of learning at school. Curricular subjects that are covered are natural science and ethics (societal responsibility, environmental awareness, social competences). The trainings were created in the three countries in their native languages. The content of the in-service training focuses on an introduction to the 15 teaching modules that were developed and also emphasizes training on combining non-formal learning with curricula. This training contains methods to recognize and analyze non-formal learning and co-operation between schools and extracurricular educational venues. It takes into account the specific needs of teachers and curricular education as well as the demand placed on future employees with key competences and the joy of lifelong learning.

We had the experience while testing the training that teachers of upper levels of secondary schools have other demands of the training than primary school teachers, for example. Therefore the project teams used a similar structure and the general content of the teacher training, but developed different training courses. The teacher training aims to spread the results and spirit of the INSPIRE project. This training manual gives other extracurricular venues and teacher education institutes an instrument to educate teachers in the issues of climate change and efficient energy use.

The teacher training course is available at:
http://www.inspire-project.eu/documents/index.html?sortby=name&dir=Teacher+Training

2.3 PHYSICSCOM - SCIENCE DEGREE PROJECT, ITALY

Website: *http://www.physicscom.unimore.it*

Link to the STENCIL catalogue entry:
http://www.stencil-science.eu/initiatives_view.php?id=1025

The National "Progetto Lauree scientifiche" (PLS or Science Degree Project) is a long-term project which aims at improving the awareness of high school students on the career opportunities offered with a degree in hard sciences, in response to a robust labour market demand which is facing a shortage of professionals with sound scientific background, which might slow down the development of a knowledge-based economy in Italy. The PLS is promoted by the Italian Ministry of Education, University and Research (MIUR), Con.Scienze (National Association of Deans of Science and Technology Faculties) and by Confindustria (Italian employers' federation). *http://www.progettolaureescientifiche.eu*.

The PLS finances bottom-up proposals from academic centers in four different disciplines, physics, mathematics, chemistry and material science, addressing the high schools of the respective regional areas. In the first two years of implementation of PLS, academic centers were invited to cooperate with selected high school teachers to design, implement and test innovative activities in the classrooms, particularly in the form of hands-on laboratories, to increase the interest of high school students in basic sciences. Currently, PLS is in the second phase, where academic centers are invited to standardize and diffuse their activities, and focus on teachers' life-long training.

In Modena, the Physics Department of the University of Modena and Reggio Emilia is a worldwide renown center for condensed matter physics and nanoscience. In the last decade, the Physics Department members have teamed up with scientists of the National Research Center CNR-NANO S3 on nanoscience, designing new activities for high schools within the PLS.

To achieve the goals outlined by the national Science Degree Project (PLS) and to increase the interest of students in undertaking hard sciences studies, the PysicsCom Team started from its first-hand research laboratory experience, with the purpose of conveying the idea that nanoscientists use quantum physics to manipulate matter and design new materials with predefined properties. Therefore, nanosciences and technologies represent an ideal playground to promote among students the idea of modern physics not as a sort of abstruse and exotic world which can, at most, explain the properties of matter (e.g. the different conductivity of materials), but as an in-depth knowledge of the functioning of nature which can be used for new material design and innovative technologies. Nanoscience is also, by nature, a multi-disciplinary field since it represents the basis of possible technological revolutions and it is close to contemporary semiconductor-based technologies. Nanoscience may therefore motivate teachers from different disciplines (physics, chemistry, biology) to collaborate on common curricula, and may motivate students who can appreciate the practical consequences of basic science studies. Therefore, we believe that nanoscience is an interesting field of knowledge, proper to convey the idea of condensed matter physics as a fast developing field which is playing a fundamental role in the development of current ICT technologies as well as in future technological revolutions.

For this purpose, the team has designed an integrated set of differentiated activities, PhysicsCom, which addresses either entire school populations (classrooms), more motivated selected students, or high school teachers. Moreover, the above-mentioned activities range from general themes of modern physics to specific laboratory activities and career paths, in order to relate students' personal interests in science to their ambitions and future careers within the job market.

The five activity areas:

1. modern physics seminars at schools' sites, typically addressing 1-2 classes of the last two years of high school (both technical schools and liceum with scientific or human science curriculum)
2. a one-week summer school on nanoscience for selected students (~40) which include lectures, hands-on labs (both experimental and simulative) in modern physics and nanoscience with expert tutoring from a researcher, as well as activities addressing social issues of science (theatre, seminars on issues in science)
3. a two-day workshop on careers, with students meeting professionals from the physics job market
4. teachers' training in modern physics with hands-on laboratories (~20 teachers per course)

5. an innovative web-based resource on the physics of waves, related to sound and music instruments (*www.fisicaondemusica.unimore.it*).

The PhysicsCom team is composed of active researchers from universities (University of Modena and Reggio Emilia) and nanoscience research laboratories (CNR-NANO S3) in cooperation with selected high school teachers of the district. Organization is within the scope and methods of the National PLS. Most activities are conducted at the Physics Department site of the University. A website (*www.physicscom.unimore.it*) was purposely created to release the different initiatives and to bring newsletter subscribers up to date.

3 Collaborative approaches to science teaching: School Partnerships

Contribution: Peter Csermely, Semmelweis University, Budapest, Hungary
Monika Réti, Institute of Education Development, Budapest, Hungary

21st century challenges defy schools in many ways. It has changed how science addresses and attempts to solve problems: networking, team-work, critical approach and emphasis on applications are nowadays common features of how science is exercised. It has also changed how solutions offered by science and technology become part of industrial procedures or everyday life and how these practices are accepted or appreciated by the larger public. Furthermore, it has also changed how we understand the very process of learning and what our societies and economies expect from schools: besides content knowledge (which is still inevitably essential), learners are expected to possess skills and hold competencies such as flexibility, collaboration, systems thinking, individual problem-solving, self-motivation and self-development.

Schools are coping to meet all new requirements and yet are very often criticized of failing their commitments. We claim that in the traditional way it is hardly possible to create learning environments that inspire students for learning science subjects. The lack of original learning experiences: stimulating (non-routine) situations, opportunities to apply content knowledge, cases to see how science and technology are used to solve problems, chances to co-operate with others or occasions to meet practitioners of science and technology lead to disinterest, and even worse: depreciation or negation of the relevance of science and technology.

To make the state of the art even more complex and arduous, schools face a double assignment in science education. As for the majority of students, they have to develop science competencies essential for making well-established choices in everyday life supporting decisions concerning health, risk avoidance, environmental consciousness or sustainability issues. In this case, schools have to cope with prejudice and negative attitudes originating from previous failures, bad experiences and discouraging narratives. At the same time, schools also need to motivate and improve the knowledge of the minority of excellent and motivated students, who are likely to choose careers in the field of science and technology. It is an extremely delicate task to balance between these extremes.

The diverse competencies needed for completing such subtle teaching tasks in schools can rarely be excelled in a single person. We might all know exceptional cases, where single teachers initiated changes and developed a genuine way of learning in their practice – but it is also observed that most of these initiatives remain isolated and generally fade or expire, if the innovators finish or change their career.

If schools are hardly apt to meet these criteria alone, what learning arenas can provide attractive and meaningful exploits that generally support learning? Networks are inevitably one of the most substantial gears for ameliorating education at all levels.

Networks within the school as a learning organisation create an inviting sphere, where all actors find their ways to contribute to more colourful and balanced education. If they manage to link to other sectors, building local and regional networks, they find a unique opportunity to interact with real practitioners and gain original learning experiences (not to mention other benefits such as meeting role models or participating in intergenerational learning processes). Such learning arenas may be constructed by the collaboration between schools and institutions (such as museums, research institutes, universities) or between schools and local communities, municipalities, service or industrial companies as well. Exemplar cases in the book provide inspiration for all to search for possible partners and develop networks. The variety of acquaintances and explorations available through such collaboration may create a true “learning niche” for all participants involved. Moreover, a diverse network of connections will stay robust even if one or two links or network-building persons become temporarily unavailable.

Therefore the mission of the 21 members of STENCIL Network taken by promoting innovative practices, supporting innovators and linking them to other actors, is of an exceptional relevance. As the network includes countries with essentially different traditions (in cultural approach to science as well as in the notion of school learning itself), such a knowledge building process should result in a colourful set of experiences that could serve as a disparate basis from which schools can collect ideas and impulse for networking and innovation. It is also a key question of raising policy-makers’ attention to the significance and the benefits of new learning arenas – in this field STENCIL also proposes distinctive actions.

Last but not least, let us highlight the importance of talent support. If that is realised as a part of a pyramid with a wide base (meaning that every student may hide a piece of particular talent), it inspires all participants, while providing opportunities to develop exceptionally gifted students. Joint aims and efforts within such networks empower students and teachers, inducing and encouraging new ideas, sustaining the motivation and the dedication of all partners involved. The kaleidoscope of divergent skills, methods and activities available in these networks assure that all participating students are valued, tutored and oriented towards unfolding their best abilities. Therefore for initiatives to renew science education talent-support networks that successfully operate in Hungary (*http://www.geniuszportal.hu*) or Poland and have been in progress in several other EU countries (such as Denmark, Germany or UK, see *http://www.TalentDay.eu*) represents a very important resource and support.

3.1 Young Researcher for Development of Šaleška Valley, Slovenia

Website: *http://mladiraziskovalci.scv.si*

Link to the STENCIL catalogue entry:
http://www.stencil-science.eu/initiatives_view.php?id=1038

The objective of this initiative is to attract young, gifted people and to motivate them for research work, which can result in potential benefits for local communities. The participants get the opportunity to:

- develop their abilities;
- gain new knowledge and experience;
- participate in teamwork;
- meet new people;
- present themselves to the public;
- get necessary skills for successful presentation of their work;
- get scholarships for further public education;
- get other references (Portfolio, Europass).
- increase self-confidence and a sense of self-fulfillment.

The projects developed by young researchers are covering all subjects learned in schools, however the focus is on solving or analyzing problems (which is usually not done within the official school curriculum).

There are several activities from teambuilding, problem searching, problem solving, preparation of reports and the presentation of project results to the public. The initiative is run by the School centre Velenje and targets the following groups:

- students in their last four years of compulsory education;
- students from upper secondary schools;
- students from universities, independent higher education institutions and higher educational colleges.

The participants attend courses, where they get the basic skills and knowledge on science methodology. When working on a project, they receive help and guidance from a mentor (e. g. how to prepare a presentation). All in all, the initiative applies several different methodologies, such as hands-on approach and activities, peer-to-peer education and E-learning. The main result of this initiative are the research projects. In 28 years young researchers completed 980 research projects (384 pupils, 571 high school students and 25 university students). Projects covered different fields from natural science, technology to social and environmental science. Several ICT tools are used in initiatives as websites (for communication and promotion), MS Powerpoint (for preparation of presentations), statistic packages (for processing the data), and programming languages (for development of application used in the project). The positive results of this regional initiative could

be extended on a European level. In Slovenia there are several regional initiatives and there are national annual competitions of projects coming from different regions. A similar model could be used on a European level. The main education resources developed in the framework of this initiative are the research projects, which are published in Cobiss, on the initiative's webpage and in the library of the School Centre Velenje and in Library Velenje. This way the research projects are made available to the general public. Students expand their knowledge and improve their skills necessary for R&D work. Participants are motivated to be creative and find problem solutions. Several participants decided to study the topic they covered in their project and became successful in their professions. Usually successful young researchers have successful professional careers. In addition to the above mentioned added value for the students, the region and the country as a whole benefit because of this initiative in terms of human resource development. Basic activities are funded through continuous, regular funding. The movement has been growing for 28 years and has become almost a culture in Šaleška Valley, so there is no problem with sustainability. There is a strong network of volunteers supporting the initiative.

3.2 ACT4RIVERS – ACTIVE CITIZENS FOR FRESHWATER ECOSYSTEMS, AUSTRIA

Website: *http://www.act4rivers.net*

Link to the STENCIL catalogue entry:
http://www.stencil-science.eu/initiatives_view.php?id=1073

The 24-month project "Act4Rivers – Active Citizens for Freshwater Ecosystems" (funded through the COMENIUS-programme) developed a **5-day teacher training course** to raise the level of information about the European Water Framework Directive and the knowledge of teachers about "a good ecological condition" of freshwater ecosystems. The course is mainly **targeting teachers of science** (Chemistry, Biology, Geography, and Physics), languages or humanities at secondary schools from all over Europe but also teacher trainers, scientific staff of universities and research institutes or non-formal educators.

The training course exploited the content, method and tools developed in "Free your River", a SOCRATES/MINERVA-project which was successfully completed in 2007. They are available on *www.freeyourriver.net*. It also promoted innovative didactical strategies, including IT-based and cross-border strategies, combining experiential learning at riverbanks with cross-curricular classroom teaching and collaborative approaches, enabling teachers to support pupils in acquiring new competences and skills. Course participants increased their basic competence in science, their digital competence, the competence to communicate in foreign languages and their social and civic competence, which they can later transfer into their daily work.

A major focus was put on making the participants aware of the fact that people have to act as "active citizens" in order to achieve a "good ecological condition" of freshwater ecosystems as mentioned in the directive. Thus, active environmental citizenship has to be addressed in school. It's essential that **teachers act as "active citizens" themselves and manage to encourage their students to do so – both within and outside the educational system**. Course participants were provided with a didactical concept and tools to integrate this topic into teaching and enabled to address active environmental citizenship.

During the project, a test training course in Austria and a regular training course in Romania were organized. They were evaluated comprehensively to ensure a high-quality outcome of the project and the experiences made formed the basis of the "trainer manual". It covers every course day in detail and helps future course organizers to organize courses on freshwater ecosystems, on using the Internet for collaboration (even on a European level) and on taking action on local water projects. Both the trainer manual and all the course materials for the participants

were made available on *http://www.act4rivers.net*. They can be downloaded for free in English, German, Italian or Romanian.

"Act4Rivers" was completed successfully in October 2010. The project consortium consisted of 8 partners from 5 countries (Austria, Germany, Romania, Italy and Belgium) and was coordinated by Education Group from Linz, Austria.

3.3 Comenius Action CO1-17/2005 Waste management, MALTA

Link to STENCIL catalogue entry:
http://www.stencil-science.eu/initiatives_view.php?id=129

Nearly everyone is aware of the huge amount of waste generated in Malta, but few are the ones who respond to it. Some people simply do not care and prefer to complain rather than take action. Others are more interested but are troubled by the frequently asked question: What can I do? I am just one person. At St. Aloysius College, Malta twenty students got together under the direction of teachers Mr Servolo Delicata and Ms Theresa Friggieri to try and come up with some solutions. Thus the Waste Management Service was born as part of the St Aloysius College Comenius Project (2004-2007). The project aims to reach out to both of the opinion groups mentioned above. The two main objectives of this project are to generate awareness about the waste problem and provide means by which one can help ease it, promoting active citizenship. The group divided roughly into two according to which objective each person was to tackle. Awareness is the first step before response. It is important to start responding to the waste problem as the future will depend on people now and their values. A new behavior pattern was encouraged when disposing of waste. At St. Aloysius College the focus is mainly on recycling as what we call waste can actually be a means of generating wealth. This is because this separate waste can have other uses. Posters bearing briefing steps on how to recycle at the school were produced as well as another bearing the logo Recycling for a better world. Another original poster produced carried the words: This class is recycling...are you? and was put up in the classes that contain the recycling bins. A leaflet was produced containing the objectives of the project and answers to some frequently asked questions. Apart from this some students participating in this project gave a presentation to students of St. Dominics College, London who were on a Comenius visit. As part of the recycling initiative, four bins were placed in each class, for white paper, plastic bottles, metal cans and other waste. A bin for glass was not included since there is rarely any glass to throw away. On a regular basis, the separated waste would be emptied into larger bins which were provided by WasteServ Malta, the agency responsible for implementing the Waste Management Strategy for Malta. In this manner, not only was a practical way produced by which to recycle but also an example was set by recycling and by verbally correcting those who do not recycle. Currently the seeds of awareness are being sown. They are being watered by providing the proper means of recycling. Hopefully they will grow and develop into a complex tree which represents changes both in attitude and in behavior, regarding waste.

4 NEW PEDAGOGICAL APPROACHES (INNOVATION IN TEACHING AND LEARNING)

4.1 NATIONAL COMPETITIONS OF MATHEMATICS, BIOLOGY, PHYSICS AND PORTUGUESE LANGUAGE, PORTUGAL

Website: *http://pmate.ua.pt*

Link to STENCIL catalogue entry: *http://www.stencil-science.eu/initiatives_view.php?id=633*

The school's success, particularly in Maths, is a matter of great importance nowadays. To know how to bring this about is a priority in all school grades. It was on this basis that the Projecto Matemática Ensino (PmatE) was born in the University of Aveiro, in 1990, a vanguard project that foreseeing the current status, started since its inception to develop computer tools and contents in several areas of knowledge. Its main goal is to increase interest and success in Maths. The creation of a digital structure for the presentation of contents named "Models Generated Questions" (MGQ) [Question Generating Models] made PmatE a pioneer in the way of representing Maths. This unique philosophy in Portugal, and perhaps in the world, makes PmatE a singular project, whose longevity states its relevance throughout the years in the promotion of interest and success in Maths, as well as other areas of knowledge, namely Biology, Physics and Portuguese Language. Since

1990 it has been developing a platform only available in the Internet - *http://pmate.ua.pt* - that, besides including all school grades, develops contents either in the way of competitions or in the formative mode (evaluation, diagnosis and practice). PmatE has currently three main pillars: the communication and diffusion of science; school intervention; and cooperation with countries who share the same official language - Portuguese.

The essence of the project are the ICT competences. The creation of a digital structure for representing the content of different scientific areas, called “Modelos Geradores de Questões (MGQ)” became the core of the project. The “Modelos” elaborated by the teachers of each school subject with scientific, pedagogical and technological relevance are a fundamental part of the PmatE Software. The software “MGQ”, works on a random basis. The questions, even with the same aims, are generated differently, allowing two or more users to work on the same concept simultaneously.

Every year, PmatE promotes 8 National Science Competitions: one for each school degree, from Primary to Higher Education, and one for all school degrees in the network. More than 5000 students took part in the Network competitions and 15 000 came to the finals at the University of Aveiro, transforming the University Campus of Santiago in a huge national celebration of Maths, Physics, Biology, Geology and Portuguese.

4.2 EUDOXOS - TEACHING SCIENCE THROUGH ASTRONOMY USING THE INQUIRY TEACHING MODEL, DIGITAL MATERIALS AND CUTTING EDGE INFRASTRUCTURES, GREECE

Website: *http://www.ellinogermaniki.gr/ep/eudoxos*

Link to the STENCIL catalogue entry:
http://www.stencil-science.eu/initiatives_view.php?id=1042

The initiative is promoted and run by Ellinogermaniki Agogi and it includes a number of European projects that are funded from the European Commission. These projects are:

Eudoxos: Teaching science with a robotic Telescope, Discovery Space, COSMOS: An advanced scientific repository for science teaching and learning, SkyWatch: Introducing European youth in the world of scientific research through interactive utilization of a global network of robotic telescopes, Discover the COSMOS: e-Infrastructures for an Engaging Science Classroom.

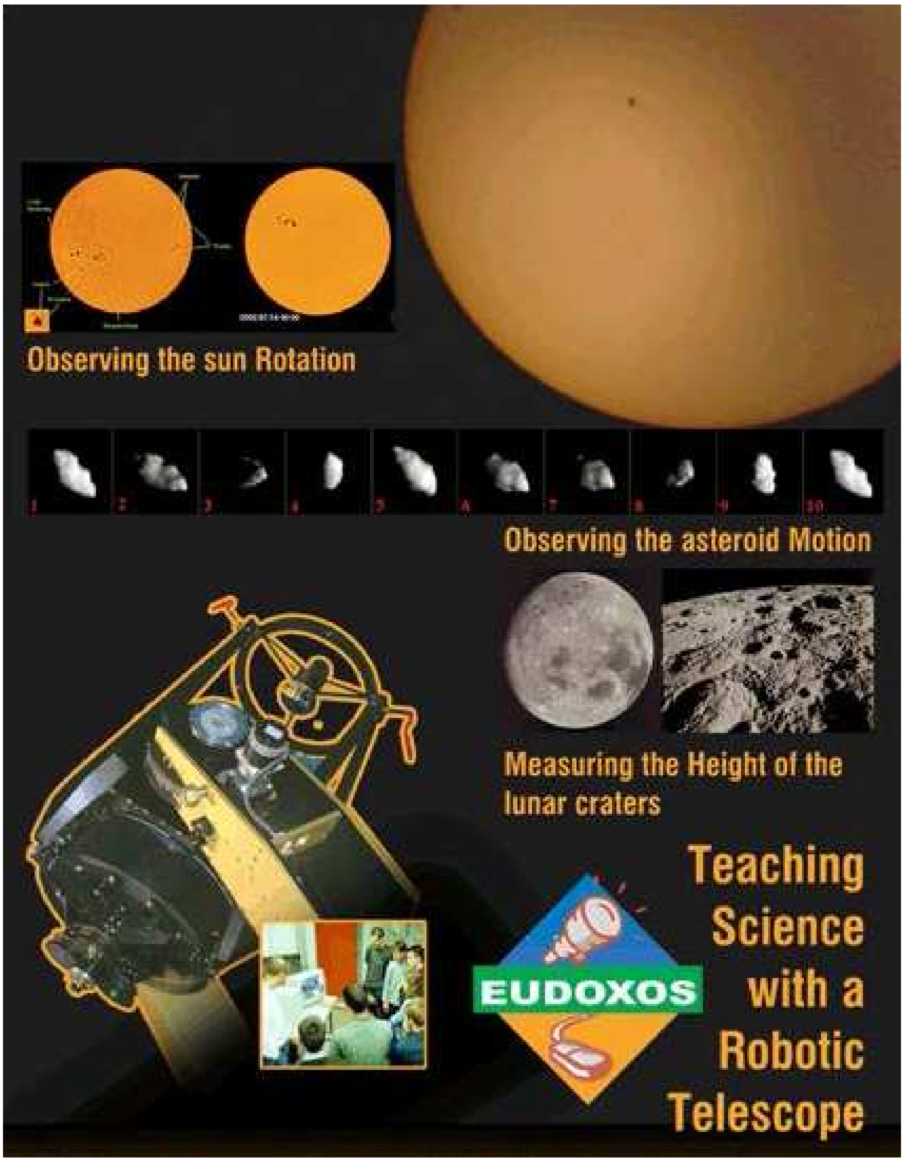
The objectives of this initiative focus on introducing the scientific methodology in school science education, through astronomy and by utilizing existing research infrastructures of frontier research institutions enriched with online tools (data analysis tools, simulators & games) and web-interactive educational materials, educational activities that follow the inquiry based science education model and awareness raising activities such as science fairs, astronomy days, contests, training workshops and summer schools.

Although the activities involved mainly focus on astronomy the subjects taught cover all areas of natural sciences (physics, biology, chemistry) and are also suitable for teaching computer science and mathematics. The activities included cover all stages of primary and secondary education as well as the first two years of undergraduate studies in science. All the activities share a common basic structure as their educational design is based on inquiry based learning. The results of the realization of such activities over the years are the increase of students' interest towards science and the creation of a large learning community that has enforced collaboration between schools and between schools and science centers. The motivation of local societies and the increase of their interest towards matters of science is also an outcome that has been produced over the years.

Students and teachers have the chance to use major scientific infrastructures, like networks of robotic telescopes in order to produce astronomical images, digital libraries of educational content where data or activities can be retrieved from, software for the process of data, simulations and game-based applications. These ICT tools are used to implement educational activities and help students get a first hand idea of how astronomers work and what kind of equipment and facilities they use.

http://www.cosmosportal.eu/ (on-line repository),
http://www.discoveryspace.net/ (users interface, network of robotic telescopes),
http://www.ellinogermaniki.gr/ep/eudoxos/etool/index.htm (e-tool)

The model behind the educational activities that are integrated in this initiative are based on inquiry science teaching which has proven to be the most effective approach when it comes to implementing activities in different counties, schools of different backgrounds, training centers and research centers. The applications and the respective scenarios of use offer a “feel and interact” user experience, and they have been tested in different educational settings in Europe and beyond and they have proven their efficiency and efficacy as inquiry based resources.



The initiative promotes inquiry based pedagogical strategies proven to be popular amongst females. Moreover, contexts like that of space exploration and life discovery that have proved to be interesting to boys and girls alike are used.

The success of the awareness raising activities that are conducted in combination with the outcomes produced from the application of educational activities in schools contribute in the further dissemination of the initiative and the further organization of astronomy-based events that inspire young students and motivate them to engage further in scientific inquiry and in following scientific careers. Moreover, the scaling of in-school events and their evolution into regional or national events due to the increased interest of the school communities may even motivate stakeholders at national and European levels to promote astronomy and science in general. An example of such an outcome is the declaration of the year 2009 as the international year of astronomy.

The educational repository that is integrated in this initiative involves over 200,000 educational resources on astronomy. Within these resources there are hundreds of complete high quality educational activities on different astronomy-related topics that cover primary and secondary education. Moreover, an extensive pool of astronomical data and data analysis tools are also available to all users allowing them to carry out the existing activities or create their own.

Currently these resources are used by teachers and students of primary and secondary education all over Europe, amateur astronomers, and people who have a general interest in astronomy.

All resources are available at COSMOS repository: *http://www.cosmosportal.eu/*

Students participate in group exercises that improve their social skills and enhance the interaction among fellow students. They get the chance to work with real experimental infrastructures, speak with astronomers and learn how real scientific work is done.

Schools may participate in national or European contests and science festivals. Moreover, the collaboration between schools and research is improved through the implementation of advanced technological tools and applications that simulate how science works, improved educational practices and learning processes in science and mathematics.

Through the organization of local events like science festivals and astronomy nights the local community is mobilized and their interest in science and astronomy is increased.

Activities created in the framework of this initiative are designed in accordance with the latest proposed methods of scientific inquiry in education and may be included in a country's analytical programme through respective contests. Stakeholders that participate in activities of this initiative like training workshops or demonstrations may be inspired to improve their country's science education system.

A multinational dimension of the activities is provided, gathering in parallel, members, networks and strong local co-operations all over Europe. Furthermore, actions towards the effective communication and dialogue between research and education at a European level are introduced, so as to enable society at large to

have a better-informed and more constructive influence on the future development and governance of science, technology and innovation.

The initiative aims to introduce and consolidate the methods of scientific inquiry in education, in accordance with the Rochard report. Furthermore this initiative aims to become a successful paradigm of effective science teaching and to motivate the learning community into adapting its practices in other science related areas besides astronomy.

Through this initiative a series of outreach activities are materialized: a) conducting of students' and teachers' astronomy contests and other dissemination events b) collection of Best Practices that focus on astronomy-related subjects c) engagement of educational communities in the implementation of these Best Practices on a large scale in Europe. By these activities, the initiative intends to demonstrate effective ways of involving a broader set of actors in the use of research infrastructures in education attracting young people to science and pooling talent in scientific careers. Furthermore, it aspires to foster a culture of cooperation between research infrastructures, by spreading good practices between outreach groups of large scale research infrastructures, encouraging them to develop their activities in complementary ways and optimise their use by demonstrating how astronomy e-infrastructures could support the vision of the science classroom of tomorrow.

The components of this initiative are the brightest example as to sustaining the produced results as they are all rings of an expanding chain. Over the years a series of different European projects that are included in this initiative have come to add an extra piece in the repertoire of available possibilities creating a complete package for teaching astronomy efficiently, that includes all the necessary tools, from large scale infrastructures like telescopes and networks of robotic telescopes, to a rich in educational content repository and a set of awareness raising and dissemination activities like contests, science festivals and astronomy nights. All these different parts are designed so they may interact with each other like parts of the same engine that has been designed to promote scientific inquiry in schools and society.

4.3 EDUJUDGE: INTEGRATING ONLINE JUDGE INTO EFFECTIVE E-LEARNING, SPAIN

Website: *http://www.edujudge.eu*

Link to the STENCIL catalogue entry: *http://www.stencil-science.eu/initiatives_view.php?id=1072*

The UVa On-line Judge (*uva.onlinejudge.org*) is a successful on-line programming trainer created in 1995 with the aim of training users who participate in worldwide programming competitions. Users can submit solutions to the proposed problems and the Judge automatically indicates if the code is correct. Many of these users were demanding a greater pedagogic character for this tool and from this necessity the EduJudge project was conceived.

The main aim of the EduJudge project is to integrate the UVa Online-Judge into an effective educational environment, such as a Moodle platform, in order to satisfy the users' demand for a greater pedagogic character and, in this way, facilitate the use of this tool as one more activity for official courses.

The target groups of EduJudge are students and teachers of the University sector and post degree, for several technical and science degrees, and of secondary schools, for the computing field.

The main result of the EduJudge project is the EduJudge system, a system to learn mathematics and programming with the enjoyment of participating in contests. EduJudge is made up of three main components integrated into Moodle. Firstly, the UVa On-line Judge is an evaluation server that automatically evaluates the correctness of a computer code and provides students with its feedback. Currently this tool has more than 100,000 registered users and more than 2,700 problems. In the second place, QUESTOURnament allows the development of contests in the Moodle platform and students can compete among themselves trying to solve a set of timed quizzes. Finally, CrimsonHex is a specialized and interoperable repository of learning objects, providing content to several types of services.

Moreover, two important outputs of the project, very useful for dissemination, are the following books: On the one hand, the book entitled *"A new learning paradigm: competition supported by technology"* is addressed to researchers interested in different learning strategies and ICT tools, as well as to teachers interested in applying competitive learning strategies into their courses; On the other hand, the book titled *"EduJudge system handbook: How to organize programming competitions in Moodle courses"* is addressed to the users of the EduJudge system, users of Moodle, teachers interested in organizing on-line contests as a pedagogic resource, etc.

In most dissemination activities, attendants were referred to the EduJudge website to be updated about the information of the project. From 14th October 2008 until 31th May 2010, 8,301 visits to the EduJudge website were registered using Google Analytics. In addition, some target users, mainly teachers of programming subjects, have contacted the consortium wishing to test the system in their classrooms.

In order to ensure sustainability of the results of the project, an Intellectual Property Rights Agreement has been signed by the partnership. For the moment, the consortium is allowing the free use of the system by teachers who are interested, with the aim of getting a track record of successful experiences and making the system known to the educational community.

Project Number: 135221-LLP-1-2007-1-ES-KA3-KA3MP

Programme/Sub-programme: Transversal Programme / Key Activity 3: ICT (Multilateral Project). **Project Duration:** 29 months (January 2008 - May 2010)

Project Coordinator: *CEDETEL* - Centre for the Development of Telecommunications in Castilla y León) - SPAIN

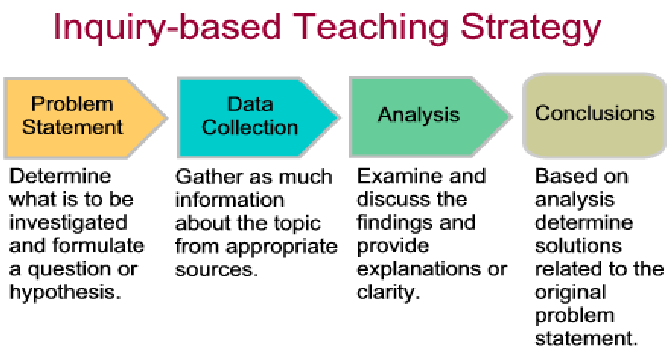
Project Partners: *Universidad de Valladolid* (University of Valladolid) – SPAIN; *Universidade do Porto* (University of Porto) – PORTUGAL; *Kungliga Tekniska Högskolan* (KTH Royal Institute of Technology) – SWEDEN; *Matematikos ir Informatikos Institutas* (Institute of Mathematics and Informatics) – LITHUANIA.

5 SCIENCE EDUCATION AS A MEAN FOR KEY COMPETENCES DEVELOPMENT

CONTRIBUTION: PROF. MARTIN OWEN

The Rocard Report for European Commission recommends renewal of schools' science-teaching pedagogy by "introduction of inquiry based approaches in schools" (Rocard, 2007: 22). This reinforces the role that science education can play in the development of key competencies. Inquiry Based Science Education (IBSE) involves students in using a broad spectrum of key competencies in relatively authentic contexts at a variety of levels.

The figure 1 below describes a workflow for a student in IBSE (from *http://www.worksheetlibrary.com/teachingtips/inquiry.html*).



These are clearly indicative of language and mathematic skills, information processing skill and problem solving. Further Levy ((Levy et al., in preparation), adapted from Asay and Orgill 2010) suggests that 7 essential features of learner activity IBSE are:

- **QUESTION:** students investigate scientifically oriented question
- **EVIDENCE:** students give priority to evidence
- **EXPLAIN:** students formulate explanation based on evidence
- **CONNECT:** students connect explanations to scientific knowledge
- **COMMUNICATE:** students communicate and justify explanation
- **REFLECT:** students reflect on the inquiry process and their learning

If this is what the core of Science Education in the 21st Century Europe is about it is easy to map onto key competencies.

Questioning: To develop meaningful language skills in oral and written form – to face the verbal challenge of third parties and have the language resources to refine from a percept to something expressed as a question in language.

Evidence: To undertake procedural activities that are recorded for potential replication – to record activity in a way that others can understand. It is the ability

to undertake recording activities – to sort the relevant from the irrelevant. To be able to interpret numerical and other information formats. It is the ability to discriminate between relevant and irrelevant. To know why it is important to hold variables constant – to appreciate the meaning of "variable" and "proportion". It involves measuring, checking for accuracy, approximating and making judgments in context. It means that the learners develops the ability to understand the word "valid".

Explain: Learners look for patterns in data, to manipulate numbers in ways that provide evidence. Learners create visual representations of ideas represented in numbers through graphs and charts. Learners learn to translate between numbers and words and vice versa. Statistics – the cornerstone of understanding the world.

Connect: Learners become researchers – they learn how to find knowledge that already exists and how what they are currently investigated links with everything else. It is library and digital searching skills. It is also about seeing the relevance of what they are doing in the context of a wider world.

Communicate and **Reflect** are almost self-explanatory – however the emergence of "infographics" as means of communicating data as a key skill has special relevance in communicating science.

Thus any modern approach to the study of science in education provides an excellent platform for authentic acquisition and application for key competencies.

REFERENCE: *Rocard, M. (2007). Science Education NOW : A renewed Pedagogy for the Future of Europe, European Commission, Directorate-General for Research, Information and Communication Unit. Brussels. Available at: http://ec.europa.eu/research/science-society/document_library/pdf_06/report-Rocard-on-science-education_en.pdf [Accessed 29/09/2011].*

5.1 SUPPORTING TEACHERS THROUGH THE INVOLVEMENT OF SCIENTISTS IN PRIMARY EDUCATION (ASTEP), FRANCE

Website: *http://www.lamap.fr/astep*

Link to the STENCIL catalogue entry:
http://www.stencil-science.eu/initiatives_view.php?id=596

“Supporting teachers through the involvement of scientists in primary education” (ASTEP) is one of the initiatives managed at the national level with support from the Academy of Sciences, in addition to various teaching methods already implemented in primary schools, to facilitate the teaching of science and technology consistent with the curricula and to give pupils the means to achieve the knowledge and skills defined by the common core. A national steering group holds regular national conferences and seminars to support the deployment of the initiative in the different academies (text adapted from the Ministry website). Funding is provided by the Ministry of National Education and the Ministry of Higher Education and Research. **At the academic level**, a regional pedagogical inspector (IA-IPR) provides the link between the scientific community and the world of Education. S/he works closely with the science contact person. S/he organises meetings with all actors in the regional institution of National Education (“Académie”) and shall annually submit to the chief education officer (“recteur”) a report on actions undertaken and prospects. **At the Departement level**, an inspector of National Education (IEN) provides information necessary to promote the ASTEP in the constituencies, identifies available resources and organise them according to the needs. S/he also organises, in conjunction with the science contact person, a monitoring of accompanying actions and presents to the IA-IPR an annual assessment that supplies the academic report. A science contact person (usually a teacher-researcher) develops the initiative in the different structures of higher education in his academy. S/he proposes the creation of teaching units (EU) that validate these activities in the curriculum of students. S/he recruits and trains university tutors of students. S/he closely works with the IA-IPR. In fact, the IA-IPR and the science contact person are the two keystones of the initiative. The project mainly concerns primary education (3-11 years old). However, some initiatives concern also secondary classes (11-18 years). They are usually class projects supervised by a teacher-researcher.

In order to develop inquiry-based learning in the classroom, ASTEP (Supporting teachers through the involvement of scientists in primary education) aims to promote a system where the research scientists, engineers, professional technicians and science students commit themselves to participate actively in supporting primary school teachers and their pupils. Professional scientists and science students can indeed make key contributions to teaching. As active players and witnesses involved in everyday’s professional and research fields of science, they provide by themselves stimulating and living examples. They can also facilitate

teaching on the primary school level by providing support in ways that have considerably developed over the last few years.

All the scientific disciplines of primary school curriculum are concerned. The following table gives a description of the 164 projects developed in Lorraine Region.

9%	14	**Sky and Earth**
29%	48	**Material**
20%	33	**Energy**
7%	12	**The unity and diversity of life**
6%	10	**The functioning of living**
5%	9	**The functioning of human body and health**
3%	5	**Living beings in their environment**
20%	33	**Technical objects**
	164	

The science **inquiry-based approach** (many of the answers below are taken from the methodological guide of the Pollen project:
http://www.pollen-europa.net/?page=%2Bag%2BXQhDnho%3D

The first step shall be to choose an area of study that falls within the students' cultural environment (germination, shadows, levers, food, electrical circuits, etc.), curricula and general objectives suited to children of the age group under consideration. The situation needs to encourage the students to raise questions and culminate in a statement of the problem to be solved, with the problem possibly requiring time before it is actually solved. It is important to manage to state the problem, as science is built on problems to be solved, and not just observation alone.

In some cases, the study can also begin with a question (How is the melting temperature of ice measured? How is saltwater made? How can saltwater be cleaned? etc.). Insofar as all starting situations are intended to lead to the emergence of a problem and spark action, the wording of the initial question is important. Careful though, there are many questions that simply cannot facilitate activities and the reasoning process, as opposed to meaningful questions, which, in contrast, lead to intellectual or manual activity in the children – to an inquiry.

The students need time to think on their own and exchange ideas amongst themselves (and not necessarily through the teacher). The teacher needs to take the students' ideas seriously and then, taking their questions into account, he or she can hold a group discussion to give the students an opportunity to realise that ideas other than their own exist and that those ideas can be rooted in facts that they had not considered. In certain cases, they can test them through experimentation.

Experimentation here does not mean complicated experiments involving sophisticated and costly equipment. The experiments are in fact very simple and require nothing more than ordinary, inexpensive equipment. The sample activities listed on the Pollen site (*http://www.pollen-europa.net/*) are a good example of what can be done by children. Children have very good recollection of the

experiments they conduct themselves. In addition, very early on, they have ideas about a number of phenomena. They need to reach this realisation themselves, hence the need to let them test the experiments they have come up with themselves.

One of the first problems lies in the equipment available to the students. The students work alone or in groups. The teacher gives each student or group of 4-5 students the material required for the suggested experiment(s). The material is put on a table. The student works alone or the groups of students work together to reflect on the protocol and material necessary to perform the protocol that will be suggested to the entire class and discussed jointly. After each student (or group) has performed the planned experiment and noted the results achieved, all of the findings can be pooled for review. The effectiveness of the discussions depends not only on the students' skill at expressing themselves orally, but also their ability to listen to one another.

The students identify suitable variables and become aware of the need to control variables. Often, the aim will be to determine on what factors a certain phenomenon depends and test the factors, one after another.

Taking each student's results into account, connecting them back to the initial hypotheses and summarizing the information, group discussion can begin, coordinated by the teacher who ensures that everyone has an opportunity to be heard and that every viewpoint is respected. The summary process is meaningful to the child when he or she has experienced all of the preceding stages. The synthesis cannot, however, lead in any certain manner to unchallengeable knowledge, unless under the teacher's guidance, the class compares its findings with what is known as "established fact", meaning that found in books.

It is important that teachers check the background of topics in available literature. The recommended approach for teachers is similar to that of a researcher, yet also remains different. The children should "discover" nature's phenomena and properties and experiment and compare their conclusions amongst themselves, like scientific community researchers might do. However, unlike researchers, those children do not have to discover phenomena and laws that are yet unknown to the scientific community, as everything a child learns in school is well-known fact to that community.

The students can be invited, individually or in groups, to produce written documents (texts, drawings, flowcharts, graphs) that are accepted as such and used in class as one of many learning aids. In many schools, each student has an experiment notebook, which includes three types of distinctly different written media: individual writing, intermediate writing and class writing, with the first two open and minimally organised, at least at the beginning. Gradually, with the teacher's help, but also through self-criticism, the student organises his or her notes, improves spelling and comes to write more effectively.

In France, the pedagogical approach is not different for non-mainstreaming groups. However, initiatives based on the investigation approach (inquiry based learning)

usually integrates differentiated learning. Besides, La main à la pâte (Hands on science) usually urge to implement their initiatives in "deprived areas".

The national website of Hands-on science ("La main à la pâte) already includes many documents, especially as regards implementation of the initiative in one's school (*http://www.lamap.fr/?Page_Id=7*).
Some videos are produced (*http://www.lamap.fr/DVDSciences/videoDVD.html*).

This initiative is now 5 years old and is still expanding. It affects the majority of *académies* of France. It involves more than a thousand students and at least 750 classes. It is supported by:

- The Academy of Science and the Academy of Technology.
- The two Ministries (National Education and Higher Education and Research)
- The Conference of University Presidents (CPU)
- The Conference of directors of Engineering schools

5.2 EMOTION - ELECTRONIC MUSIC & USE OF ICT FOR YOUNG AT RISK OF EXCLUSION, ITALY

Website: *http://www.emotionproject.eu/eng/index.php*

Link to STENCIL catalogue entry: *http://www.stencil-science.eu/initiatives_view.php?id=1069*

The project aims to create an **innovative learning approach based on informal education, specifically on the use of ITCs in music to encourage youth to re-start learning**. The pedagogic pathway proposed **combines creativity, fun and key competences learning, particularly mathematics, sciences and ICT and offers the young at risk of exclusion or dropouts a concrete chance to reconnect to learning.** E-Music is just a tool to invest in and to elaborate upon for a pedagogic pathway in which young people in situations of social exclusion may have some interest. This results in a chance for them to **acquire the key competences and knowledge that are essential to enter the labour sector**. The project is structured into 4 main directories:

- Step 1: definition and development of the new didactic pathway, indicators to make a survey and to check the results
- Step 2: pilot projects in 3 MS : experimentation of the new pathway
- Step 3: analysis of results: comparative study
- Step 4: presentation and spreading of results Target: young people (aged 15 – 24) at risk of exclusion: early school leavers, migrants, young people without qualifications or with difficulties (social-economical, physical, personal difficulties)

Expected results: to assess the positive impact of ICT as a basic education and training tool, particularly for young people at risk of exclusion. Exploit the potential of a new didactic approach based on ICT to reduce the drop-out rate in Europe in the long term and to reduce the low skilled rate. To sensitize and draw attention to the positive influence of ICT on the learning process (particularly improvement of scientific and mathematics literacy competences). Main deliverables: **new pedagogic tool; dynamic website; audio cd-rom with all musical productions students will carry out during the pilot experiences; video clip to promote the project**; publication with the results from the analysis of the experimentation devoted to training and education decision-makers.

PARTNERSHIP ACSI - ASSOCIAZIONE DI CULTURA, SPORT E TEMPO LIBERO-ASSOCIAZIONE CENTRI ITALIA (COORDINATOR); FUNDACIO BARCELONA MEDIA UNIVERSITAT POMPEU FABRA (BM) ES; INTERDISCIPLINARY CENTRE FOR COMPUTER MUSIC RESEARCH (ICCMR) UNIVERSITY OF PLYMOUTH UK; TEHNE-CENTRE FOR INNOVATION AND DEVELOPMENT IN EDUCATION ROMANIA; LIVERPOOL CHAMBER OF COMMERCE AND INDUSTRY, UK

5.3 NATURE AND EROSION TRAINING THROUGH PEDAGOGIC GAME AND CREATIVE DRAMA IN PRIMARY SCHOOL CONTEXT, TURKEY

Website: *http://ekampus.orav.org.tr/mehmetduranoznacar*

Link to STENCIL catalogue entry:
http://www.stencil-science.eu/initiatives_view.php?id=1047

For the instruction of biological variety, environmental pollution, and erosion, the activities “Plants went to law”, “I eat you” “The Passwords of Living Beings in Nature Find me” were carried out through pedagogic games and creative drama based on constructivist theory.

It was observed that the activities carried out had positive effects on the developments of thinking critically, applying the requirements of democracy in the classroom, productive and creative thinking, competence in participating in the activities in classroom, showing scientific attitudes and behaviours, investigating, scientific thinking, having and displaying rich ideas, sharing the information and findings obtained, entrepreneurship skills, and communication skills.

“Plants went to law”, “I eat you” “The Passwords of Living beings in Nature Find me” activities were applied in Adana Science and Arts Center during the postgraduate research and in TEMA (The Turkish Foundation for Combating Soil Erosion, for Reforestation and the Protection of Natural Habitats), Junior TEMA Erosion Education Camp for three years. A survey of the students was administered a survey evaluating the activities and the results were analyzed.

It was observed that students developed positive attitudes towards the questions “Do you find Science and Technology lessons boring? What do you think of the activities we carried out?” And some of the students’ comments were as follows: “ I did not used to like science lessons before, now I like it very much” “I did not get bored in the lesson. For the first time I came to school from home so happily”. “The thing I liked most was our shouting “FREEDOM TO PLANTS” in the end. The whole school listened to us”. “I learned that all living beings have equal rights. I do not pick tree leaves anymore.”

Findings obtained from the study showed that activities based on the constructivist theory have positive effects on keeping the newly learned information in mind and using them it real life.

6 Science education for diversity

6.1 Student expeditionary eco-group, Bulgaria

Website: *http://souhristosmirnenskibrezovo.schools.officelive.com/default.aspx*

Link to the STENCIL catalogue entry:
http://www.stencil-science.eu/initiatives_view.php?id=1010

This project addresses the issue of a lack of practical experience and real life examples in science teaching. Specifically, this project connects science learning with the protection of the environment by encouraging the active engagement of students in eco-projects, combining learning assignments and engaging experiences in an informal atmosphere. The main objective of this project is to implement the students' knowledge of biology, chemistry and geography in the discovery of environmental problems in the region of Surnena Sredna gora mountain. A supporting goal is the **inclusion of Roma pupils**, **especially girls** to study. In the classwork of biology, chemistry and geography students are organized into groups and set tasks for future research. Students from all eco-groups work in a specialized Moodle-environment, part of the SCORM-based educational portal of the school, in which they prepare an agenda for future work, share the collected theoretical information and communicate with classmates. They locate major environmental problems and organize expeditions in those areas through collaborative work. This process includes thematic excursions, like two-day hikes. Students and teachers examine sites, describe the problems identified and take samples, pictures and clips. Due to the reluctance of Roma parents to allow their children (especially girls) to participate in these events, in expeditionary teams parents are also invited to participate. When students return to school, they review the materials collected, test the samples and make suggestions for solving the problem to other students and parents. A separate ICT-team that also participates in the expedition aims to establish and maintain a special website. On this website students from all eco-groups publish information about the project and survey results. The initiative is funded by the school and targets students from 14 to 19 years old, teachers and parents. The results of the eco- group are presented and promoted to students, teachers, parents from Brezovo Municipality and neighboring municipalities.

In the course of the project, group work includes project training, work in the educational portal, application of ICT in the processing of results, creating presentations, videos and promotional materials. During the work the organizers held workshops to discuss teaching methods and develop a work plan. ICT is used in three areas: preparation for the teams, processing, summarizing and presenting the results of the work and to disseminate and promote the results of the expeditions.

In preparation for expeditions students work in groups in the educational portal of the school (*http://sou-brezovo.org*). Group work is organized in a special Moodle-

environment where students and teachers communicate in an interactive mode, seek and publish information, monitor work plan activities, create a dictionary and so on.

After the expedition, students processed the samples collected in the school labs and described the results using MS Office and virtual labs. They create advertising materials (Corel Draw), clips and presentations for the results and conclusions.

A special IT team handles the collected images and videos and develop eco-site group (*http://souhristosmirnenskibrezovo.schools.officelive.com/default.aspx*)

The website published the results of the expeditions and promoted the project.

The project provides a connection between science and its application in solving real problems. This is a major task of education in school, so the project goals are fully realistic.

The project aims at solving the problem of integration of students from ethnic and religious minorities, especially girls, by increasing their interest in learning science. Group work and project training, the application of theoretical knowledge into practice and participation of girls in shipments increased motivation. At issue school about 45% of students are Roma, half of whom are girls. The project aims at solving the problem of integration of these students and increase their interest in learning science. Due to the reluctance of parents to allow girls to participate in learning outside the classroom, parents are also included in the project team. Thus, increased citizen participation in solving environmental problems of pupils and their parents occurs. As a result:

1. The project encourages students to apply their knowledge and to participate actively in their learning. Practical work and conducting of such expeditions enable all students, including minorities to train more effectively.

2. Teachers who participate in the project are experts in various fields. They prepare work plan and determine teaching methods. The team includes teachers of biology, chemistry, tourism, IT. They work together and share experiences and thus enhance their personal qualifications.

3. Students from ethnic minorities, especially girls are included in the priority project. A major challenge facing the team of teachers is to motivate these students. This is a long process of continuous work of all teachers and educational specialists in the school.

6.2 Yes we can! Mathematics for people with Down Syndrome, Austria

Website: *http://www.downsyndrom-yeswecan.eu*

Link to the STENCIL catalogue entry:
http://www.stencil-science.eu/initiatives_view.php?id=1071

At the beginning of this year (2010), a multi-lateral co-operation of six countries themed 'lifelong learning' for all EU citizens started, aiming for the development of mathematical competences for people with Down Syndrome.

Under the motto 'lifelong learning' for the European citizen, Austria has initiated a project with five partner countries, that aims to develop the mathematical skills of persons with Down Syndrome.

For decades, international literature has taken the position that persons with Down Syndrome will forever be mathematically illiterate. Our innovative mathematics project is supported by EU funds provided through the Grundtvig Programme 'lifelong learning', and one of its major goals is to abolish such prejudices and misconceptions. Individuals with Down Syndrome now for the first time have the opportunity to receive instruction according to individually tailored plans that aim to improve their numerical skills.

Specialist literature old and new broadly affirms that individuals with Down Syndrome generally show deficiencies when it comes to calculating or reckoning. Likewise the results of the multilateral questionnaire distributed as part of the Grundtvig project offers a somewhat bleak picture: According to the parents and specialists who participated in the inquiry, approximately 50% of individuals with Down Syndrome are aware of the mathematical demands in their daily lives, yet more than half display neither the interest nor the motivation to busy themselves with the mathematical problems they confront daily.

On the other hand, another 80% are capable, either alone or with assistance, of understanding and verbalizing numbers, and more than two-thirds are capable of writing the symbols.

The individuals queried also report on accomplishments in counting forward to 100, in solving simple problems of addition and subtraction, in the application of visual aids and in dealing with money and measurements.

The gate to the world of numbers is ajar, and yet it seems to jam, for the questionnaire further indicates that less than 30% of professional respondents make use of a specific didactical approach to communicate calculating skills.

More than half of the respondents (exactly 283) are motivated to utilize new didactical methods in their instruction of calculating (For detailed results of the questionnaire see "Project Report on Analysis of Need").

The method presented here for counting by using the fingers should assist to open wide the gate to the world of numbers, so that as many as possible with Down Syndrome may pass through and thus navigate the path towards "day to day mathematics".

With Austria as leader of the project, she and her partner countries Germany, Rumania, The Czech Republic, Italy and Denmark will work to develop an effective didactical concept that – based on neuro-pedagogical principles – will enable people with Down Syndrome to master simple arithmetical calculations. Specific stimulation of both brain hemispheres – through the utilization of both hands – will facilitate the acquisition of mathematical skills and promote their ideal storage in long-term memory.

This innovative method, based on the simple notion of employing our ten fingers, has the unique advantage that our 'calculating tools' will always be immediately at hand. Ultimately, throughout Europe, more than 600 persons with Down Syndrome should be able to learn to manage money and to read a clock as the first steps towards developing self-reliance and independence.

The two-year EU-project "Yes we can!" will profile the person with Down Syndrome, highlighting their needs and potential for development. For entirely too long, persons with this individuating chromosome structure have been underestimated and, as a result, improperly challenged. Thanks to the Grundtvig Programme, they will be provided the opportunity for mathematical training by means of a math toolbox suitable for workshops, a DVD and a handbook. **All information and details about the method "Yes we can" can be found on a 85-minutes DVD.**

To get a first impression of how counting and calculating by using the fingers work, watch the video under *http://www.downsyndrom-yeswecan.eu/index.html*.

PART III.

MOVING FORWARD: KNOWLEDGE SHARING FOR IMPROVEMENT

1 BEST PRACTICES AND RECOMMENDATIONS

"Science in the broader sense refers to any system of knowledge which attempts to model objective reality. In a more restrictive sense, science refers to a system of acquiring knowledge based on the scientific method, as well as to the organized body of knowledge gained through such research".[36]

Innovation and creativity in science education means "moving from deductive to inquiry-based methods."

The recommendations that have been formulated in the Rocard report back in 2007 call on the one hand for policy and on the other for practice action taking. All the European Union countries have either directly or indirectly engaged in reforms to make science education more attractive to pupils and increase performance levels in international competitions. At the current state, as exemplified from the projects and initiatives described in Part II, we are at the stage of implementing inquiry

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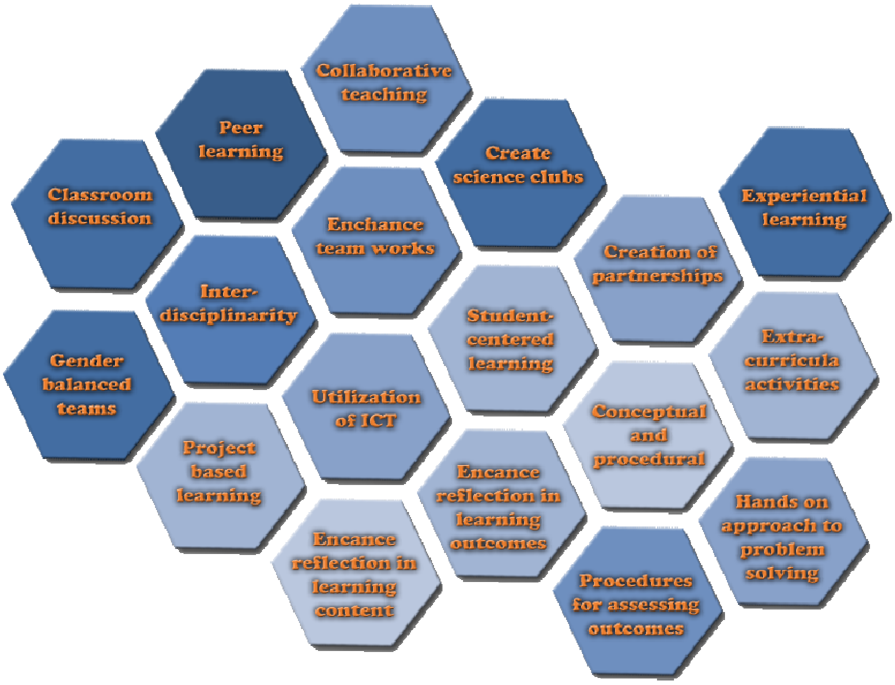
[36] Science education NOW: A renewed pedagogy for the future of Europe (2007). Available at: *http://ec.europa.eu/research/science-society/document_library/pdf_06/report-Rocard-on-science-education_en.pdf*

based methods from diverse perspectives, utilizing the capacity given by ICT, under the scope of enhancing science learning. The collected experience from the search on practices that imply change in pedagogical approaches used in science teaching suggest that teachers should consider:



2 Conferences on Science Education

A multiplicity of events and conferences are currently carried out across Europe that directly or indirectly address the parameters of innovation and creativity in science education. These facilitate the exchange of know-how and come to highlight the current trends in the field. In parallel, many great initiatives similar to STENCIL engage in defining indicators on good practices in science education.

This section aims to inform the reader about a few of the conferences that are organized annually or in the next year as an indication of where an interested teacher can turn for updated information.

Annual Conferences

Girls'Day - Future Prospects for Girls, Germany Nationwide

Website: *http://www.girls-day.de/Girls_Day_Info/English_Information*

"Every year in April technical enterprises, enterprises with technical departments and technical training facilities, universities, and research centres are invited to organise an open day for girls - Girls'Day. Girls'Day – 'Future Prospects for Girls' initiated a large campaign in which a wide range of professions and activities is presented to girls of 10 years upwards. The vocational choices of girls are influenced in a very positive way. For companies, Girls'Day has evolved as an important instrument of their recruitment policy. On the 22nd of April 2010 the successful project celebrated its 10th jubilee!"

The next Girls'Day will take place on April 26th 2012!

MINT-Botschafterkonferenz (Mathematik, Informatik, Naturwissenschaften & Technik), Berlin, Germany

Website: *http://www.mintzukunftschaffen.de*

Annual Conference, on national level, of "Messengers for Science" taking place November in Berlin. This year's conference -the 4th one, took place November 14.

Euroscience Open Forum (ESOF)

Website: *http://www.esof2012.org*

Euroscience Open Forum (ESOF) is an interdisciplinary scientific conference, is held in a leading Europe city every two years and brings together over 6000 scientists, policy makers, students, science communicators and the public (*http://www.esof.eu*). The first meeting was held in Stockholm in 2004. The next ESOF will take place 11-15 July 2012 in Dublin.

ESOF is an interdisciplinary, pan-European meeting, held under the auspices of Euroscience (*http://www.euroscience.org/*), which aims to:

- Showcase the latest advances in science and technology;
- Promote a dialogue on the role of science and technology in society and public policy; and
- Stimulate and provoke public interest, excitement and debate about science and technology.

ECSITE Annual Conference 2012, European Network of Science Centres and Museums, Cité de l'espace, Toulouse, France, May 31 2012 - June 2 2012

Theme: Space and Time, Unlimited

Website: *http://www.ecsite.eu/activities_and_resources/annual_conferences/*

Professionals from science centres, natural history museums, universities, aquariums, zoos, research institutes and private companies will converge in Toulouse in spring 2012 to discuss the hottest topics in science communication.

Cutting-edge developments in the field, over 70 inspiring sessions, debates, workshops, a range of warm social engagements and unparalleled networking opportunities for which Ecsite Conferences have become famous.

Two days of Pre-Conference Intensive Workshops will take place at Cité de l'espace on 29 and 30 May and the main Conference will be held at a state-of –the-art venue in central Toulouse. The city's famed Natural History Museum, also a partner of this year's conference, will open its doors and give you the chance to experience world-class collections and luscious bio diverse gardens.

"***New Perspectives in Science Education***" **-** International Conference, Florence, Italy, 8 - 9 March 2012

Website: *http://www.pixel-online.net/science*

The "New Perspectives in Science Education" conference has the aim to promote transnational cooperation and share good practice in the field of innovation for Science Education.

The conference is also an excellent opportunity for the presentation of previous and current projects in the science field.

"Inquiry Based Science & Mathematics Education: Bridging the gap between education research and practice" - The Fibonacci Project European Conference, University of Leicester, UK, 26 - 27th April 2012

Website: *http://www.fibonacci-project.eu/leicester*

This International Conference will set out to disseminate and explore strategies for improving inquiry-based science and mathematics through research and evaluation of innovative practice. Sessions will present the innovative work being undertaken through the Fibonacci Project in over 30 organisations in more than 20 European countries as well as have presentations on other projects focused on research and/or developing high quality inquiry-based practice.

Its objectives are to:

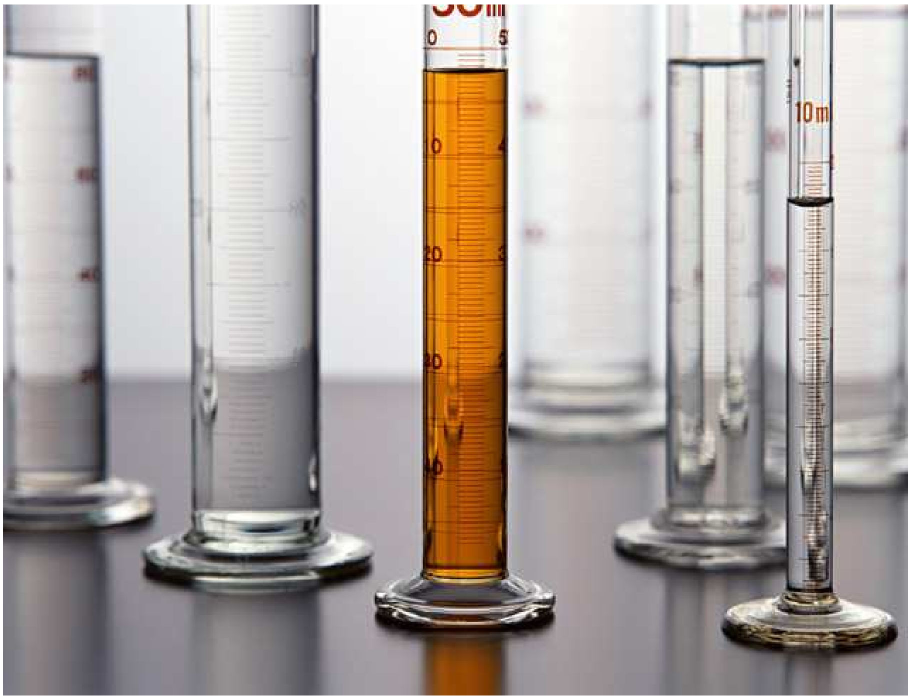
- Review the meaning of inquiry in mathematics and science education (IBSE),
- Present research and practice of IBSME,
- Bridge the gap between IBSME theory, research and practice,
- Consider strategies for integrating inquiry across curricula,
- Consider how the external environment of the school can be used to promote IBSME,
- Explore methods for carrying out evaluation and research in schools and classrooms in IBSME, and to

- Promote networks of cooperation for inquiry-based mathematics and science education.

International educationalists, scientists, mathematicians, teachers, policy makers, stakeholders and the interested public will participate in the conference.

CONCLUSION

CONTRIBUTION: PHILIPPE LECLÈRE, TEACHER / SCIENTIFIC CORRESPONDENT OF THE UNIVERSITIES OF THE LORRAINE REGION



In a world which is invaded by more and more complex technologies, countries throughout the entire world have become conscious of the urgent need to reserve a privileged place for science education in the educational system.

It seems indeed legitimate to think that scientific competences can help citizens to become emancipated and make reasonable choices.

In this context it is necessary once more to reflect about how to teach science.

The STENCIL project shows that science teaching, in the majority of the European Union countries, is still too dogmatic, providing little room for questions and reflections.

The will of different governments to act started at the end of the 1990s, and was ongoing and accentuated in the following decade. Reforms and injunctions are multiplying to change the situation. Nowadays, one can note in all countries a unanimous movement towards the acknowledgement of science education as the common knowledge of citizens. Numerous projects have been started and go in that direction. However, it is important to be sure that “the tree does not hide the forest”. There is still a lot of work to be done so that each citizen has at his / her disposal this common knowledge.

The PISA tests are considered by all countries as a veritable barometer of educational policies and their success. Everybody waits with excitement for the results, which show since their start the difficulty of putting into place effective solutions. Progress seems to be slow, sometimes there is even regress. This helps to note the discrepancy between general policy declarations and the realities on the ground.

Quite academic teaching supports, rare or not existing equipment, few and often inadequate training for teachers may help to explain in part these difficulties.

But the conclusions of subsequent reports show that there is not necessarily a link between the means put in place and the effects accounted. The Rocard report makes evident that it is necessary to revise science teaching and to make it more attractive.

An effort has been noted within all countries with regard to teacher training, but it is still incomplete and mainly concentrated on initial teacher training where there is little or no contact with the class, especially if it is linked to future teachers of secondary education. After that there is no improvement with regard to teacher training, and there has been noted an essential lack of training for teachers during their first professional years. Europe has been alerted in this regard and affirms that this situation is particularly worrying in a context of shortage of pedagogical competences. To incite teachers to engage in a lifelong training process, certain countries try to valorise their teachers in terms of career or salary.

A general reflection allows nowadays to better focus on teacher training by fostering the practice of an active pedagogy with more experimentation and consequently a higher motivation of pupils. In many countries there is a trend to be noted towards that direction.

The STENCIL project has highlighted numerous initiatives and devices which give a hint about how to make science education more attractive. For the project partners good practice is defined as an action or totality of actions focusing on the improvement of science teaching and consequently on the improvement of pupils' interest and competences. The transferability of good practices remains an important parameter which allows them to be disseminated through contagion and to include diversity and minority issues.

To highlight this notion of dissemination of good practices through contagion, there is an increase of communities of practice. The example of the PATHWAY2 project is a convincing illustration of this trend. In 2011, workshops were organised in 13 European countries, involving more than 1000 teachers and numerous responsible politicians, programme managers and teacher trainers. The workshop participants shared their own implications in IBSE (Inquiry Based Science Education) practices and were able to motivate other teachers and to create new communities of practice. A number of documents have been developed in this regard and put at disposal on pedagogical websites. To support this positive development, there is needed some institutional and coordination support, and thus some financing.

The link with the world of research also provides a way to show real and contemporary science. Seminars assembling teachers and researchers allow this exchange. Numerous research organisations have acknowledged interest in this kind of activity and are inciting their members to participate in teacher training seminars. An example is the partnership with CERN (European Organization for Nuclear Research) through the "Teilchenwelt" network.

Some initiatives also provide a citizenship dimension for all these projects by making the teachers and pupils go out of their school. Sensitising on the notion of sustainable development or on the environment has become a fundamental priority. The European project INSPIRE fosters information and experimentation on renewable energies and climate change. The INSPIRE project has the objective of improving teacher training quality and attractiveness in a context outside the school.

Science education can become an occasion of developing a wide range of competences. For example "Read, write and talk" by doing science becomes a reality if an investigative process is established in the activity. But pupils also develop other competences. They are led to confront their ideas, to find a consensus, to doubt and to put into question their perceptions, to fight against prejudices.

Certain projects are centred on the problem of the integration of pupils from ethnic or religious minorities, specifically female pupils, by stimulating their interest in science. An example of this is the "Expeditionary student eco-group" project especially designed for Roma pupils.

But as already said before, and this is also the main recommendation of the Rocard report, it is necessary to deeply reform our way of teaching science. This is, without any doubt, the most delicate issue. It is indeed difficult to change the habits of numerous teachers who reproduce the very transmissive teaching they have received themselves.

We have already taken a big step forward. In fact, educational policies in all countries affirm almost unanimously, although the ancient ones are still trying to defend a way of teaching based on the acquisition of knowledge, that pedagogical methods have to be changed to get pupils involved in science. This seems to be necessary to understand in depth the world around us. It is the key to the emancipation of the citizen.

STENCIL PARTNERS

P1: **Amitié / Project coordinator - Private training and research centre - Italy (IT)**

Website: *http://www.amitie.it*

Francesca MAGREFI - email: *fmagrefi@amitie.it*

Sibylle MOEBIUS - email: *smoebius@amitie.it*

Pier Giacomo SOLA - email: *pgsola@amitie.it*

P2: **FORTH / Foundation for Research and Technology-Hellas - Greece (EL)**

Website: *http://www.forth.el*

Kathy KIKIS-PAPADAKIS - email: *katerina@iacm.forth.gr*

P3: **ILI / Friedrich-Alexander-University Erlangen-Nuremberg / Institute for Innovation in Learning - Germany (DE)**

Website: *http://www.fim.uni-erlangen.de*

Evelyn SCHLENK - email: *Evelyn.Schlenk@fim.uni-erlangen.de*

P4: **DRE / Regional Directorate of Education (Madeira region) - Portugal (PT)**

Website: *http://www.madeira-edu.pt*

Rafael SANTOS - email: *rsantos@netmadeira.com*

Cristina PROENÇA - email: *sproenca@netmadeira.com*

Luis ALVES - email: *luis.alves@madeira-edu.pt*

P5: **INPL / National Polytechnical Institute of Lorraine (Public university of technology) - France (FR)**

Website: *http://inpl-nancy.fr*

Cyrille RAYMOND - email: *cyrille.raymond@nancy-universite.fr*

Philippe LECLERE - email : *philippe.leclere@nancy-universite.fr*

P6: **PVGM / Private Vocational School for Multimedia, Computer Graphic Design and Animation - Bulgaria (BG)**

Website: *http://www.codam.net*

Gospodin JELEV - email: *jelev@codam.net*

Lilyana ZDRAVKOVA - email: *ljkuky@yahoo.com*

Yoana MINKOVA - email: *yminkova@nbu.bg*

P7: **AL / AcrossLimits Ltd. (Maltese technology research and consulting SME) - Malta (MT)**

Website: *http://www.acrosslimits.com*

Kerry FREEMAN - email: *kerry@acrosslimits.com*

Annalise DUCA - email: *annalise@acrosslimits.com*

P8: **IPAK / IPAK Institute for Symbolic Analysis and Development of IT - Slovenia (SI)**

Website: *http://www.ipak-zavod.si*

Stanko BLATNIK - email: *stanko_blatnik@yahoo.com*

Maja LIPNIK - email: *maja.lipnik@gmail.com*

Vojko STRAHOVNIK - email: *vojko.strahovnik@gmail.com*

P9: **CRDP de Lorraine / Regional Centre for Pedagogical Documentation of Lorraine (Public education institute) - France (FR)**

Website: *http://www.crdp-lorraine.fr*

Guillaume ANDERBOURG - email: *guillaume.anderbourg@ac-nancy-metz.fr*

P10: **AdR-Bo / Bologna Research Area – Italian National Research Council (CNR) / Institute of Marine Sciences (ISMAR) - Italy (IT)**

Website: *http://www.bo.cnr.it*

Mila D'ANGELANTONIO - email: *mda@isof.cnr.it*

P11: **OE / University of Modena and Reggio Emilia-OFFICINA EMILIA - Italy (IT)**

Website: *http://www.officinaemilia.it*

Marta CONSOLINI - email: *marta.consolini@unimore.it*

Margherita RUSSO - email: *margherita.russo@unimore.it*

P12: **PhysikClub / Students Research Centre - Germany (DE)**

Website: *http://www.physikclub.de*

Klaus-Peter HAUPT - email: *kphaupt@aol.com*

Joerg STEIPER - email: *physikclub@steiper.de*

P13: **MTSN / Tridentino Natural Science Museum - Italy (IT)**

Website: *http://www.mtsn.tn.it*

Matteo CATTADORI - e-mail: *mcattadori@gmail.com*

Riccardo TIDDI - email: *riccardo.tiddi@mtsn.tn.it*

P14: **EBSSC / Primary and secondary school of Santa Cruz - Portugal (PT)**

Website: *http://escolas.madeira-edu.pt/ebsscruz*

Eduardo RIBEIRO - email: *Eduardo_infor@hotmail.com*

P15: **EBSC / Primary and secondary school of Calheta - Portugal (PT)**

Website: *http://www.ebscalheta.net*

Marco PEREIRA - email: *pmarcopereira@gmail.com*

P16: **AAOL / Anatolian Teachers Training High School - Turkey (TR)**

Website: *http://www.afyonaol.k12.tr*

Bahri TURUNÇ - email: *bahriturunc@hotmail.com*

P17: **AFYON-School / Kazim Özer Primary School - Turkey (TR)**

Website: *http://www.kazimozerioo.meb.k12.tr*

Alper GÜNGÖR - email: *alpergungor_03@hotmail.com*

P18: **TRON / Scientific High School N. Tron - Italy (IT)**

Website: *http://www.tron.vi.it*

Giorgio PIZZOLATO - email: *giorgio.pizzolato@tron.vi.it*

Fiorella PIETROBELLI - email: *fiorella.pietrobelli@tron.vi.it*

P19: **55 SOU / General Secondary School "Petko Karavelov" - Bulgaria (BG)**

Website: *http://www.55sou.net*

Viliya NEYKOVA - email: *vilian06@mail.bg*

Radost PETKOVA - email: *petkova_radost@abv.bg*

P20: **SOU Brezovo / General Secondary school "Hristo Smirnenski" - Bulgaria (BG)**

Website: *http://sou-brezovo.org*

Todorka GLUSHKOVA - email: *todorka.glushkova@gmail.com*

P21: **Galvani / General Secondary School "Luigi Galvani" - Italy (IT)**

Website: *http://www.liceogalvani.it*

Franca FACCENDA - email: *faccenda.galvani@libero.it*

ANNEX: STENCIL Grid

Selection Orientation grid for Assessing STENCIL Initiatives
Identification of Best Practices: STENCIL Book

Country:
Name of Case:

CRITERIA	ELEMENTS	RATING (choose appropriate)
Clarity of the provided documentation	- Presentation	- High, Somewhat, Low
	- Information	- High, Somewhat, Low
	- Accessibility	- High, Somewhat, Low
Relevance	- (for) Practice	- High, Somewhat, Low
	- (for) Policy	- High, Somewhat, Low
Pedagogical methodological aspects	- ICT use	- YES NO
	- Inquiry- based learning	- YES NO
	- Hands- on approach in learning	- YES NO
	- Problem oriented learning	- YES NO
	- Interdisciplinarity	- YES NO
	- Assessment	- YES NO - Please specify:
Teachers' Education	- Professional Training	- YES NO

	- Re-training	- YES NO If yes, in which form:
Collaborations	- Universities - Research Centers - Government Agencies - Other Educational Institutions	- YES NO - YES NO - YES NO - YES NO Please specify:
Equity Considerations	- Sensitivity to gender issues - Sensitivity to minority issues - Adaptability to the different learning styles of students - Promoting equality in the classroom	- High, Somewhat, Low - High, Somewhat, Low - High, Somewhat, Low - High, Somewhat, Low
Classroom Environment	- Peer learning - Motivation - Student interactivity - Material used	- High, Somewhat, Low - High, Somewhat, Low - High, Somewhat, Low Please specify:
Learning Expectations	As per specified in the National Report. What the initiative strives to achieve	
Evaluation Procedure	- Internal - External / Expert	- YES NO - YES NO
Anticipated Impact on Innovation in Learning	- Within the school - Within the national system - International - Within science education institutions - Outside science education institutions	- High, Somewhat, Low - High, Somewhat, Low - High, Somewhat, Low - High, Somewhat, Low - High, Somewhat, Low

Sustainability (flexibility of the initiative to be adapted in different contexts)	- Within the school - Within the local context - Within the regional context	- High, Somewhat, Low - High, Somewhat, Low - High, Somewhat, Low
Transferable Components	- Within the national context - Within the European context	- High, Somewhat, Low Please indicate what these might be: - High, Somewhat, Low Please indicate what these might be: