



## Efforts to Increase Students' Interest in Pursuing Science, Technology, Engineering and Mathematics Studies and Careers

National Measures taken by 21 of European Schoolnet's Member Countries - 2011 Report

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In 2001 the Education Ministers of Europe set the objective of boosting enrolment in scientific and technical fields of study to contribute to the Lisbon process of fostering a dynamic and innovative knowledge-based economy. Since then, the European Commission has set up the Maths, Science and Technology (MST) Cluster to facilitate peer-learning and development in this area, and various studies/reports at European level (including two very recent Eurydice studies on Science<sup>1</sup> and Mathematics<sup>2</sup> education and an earlier Eurydice study on Science teaching<sup>3</sup>, King's College London's report<sup>4</sup> to the Nuffield Foundation and the Rocard report<sup>5</sup>) have focused on how to improve some or various aspects of Science, Technology, Engineering and Mathematics (STEM) education in Europe.

Within the framework of the Spice project<sup>6</sup> of which it is coordinator, and at the request of its Steering Committee, European Schoolnet (EUN) undertook a comparative analysis of the main, recent STEM initiatives, policy actions and reforms in 21 EUN member countries<sup>7</sup>, based on voluntary information provided in answer to two questionnaires made available in 2010 and 2011. The EUN members and the Spice project's expert panel which answered the questionnaires used to collect information for this report, consisted of a mixture of experts, researchers, policy makers and teachers holding a relevant background and knowledge of STEM measures and issues at national level. The questionnaires' responses focused on the measures put in place to meet the challenges facing education systems: modernizing pedagogical methods; enhancing the professional profile of teachers; ensuring transitions from secondary to tertiary level; promoting partnerships between schools, universities and industry; and improving female participation in STEM studies and careers.

This report shows that two actions are at the heart of the drive to make STEM studies and professions a more popular option for young learners: the development of effective and attractive STEM curricula and teaching methods, and improved teacher education and professional development. Some countries (the Netherlands, Belgium (Flanders), Norway, Ireland, France, Israel, Switzerland, and Italy), have implemented national strategies and others have set up dedicated national, regional, or local centres (Norway, Finland, Belgium (Flanders), France, Sweden, the Netherlands, Switzerland, Denmark, the Czech Republic, Portugal, Spain, the Slovak Republic and Ireland). These centres aim to improve the quality of STEM teaching, and sometimes more particularly, to increase science and technology's popularity (also achieved through campaigns and competitions). This holistic approach usually includes all STEM subjects, covers the lifelong learning span and involves the government, educational sector and industry. Public-private partnerships are an important feature of these all-encompassing approaches, aimed at developing a sustainable scientific culture which is deep-rooted in society. Other common approaches are to establish networks<sup>8</sup> of teachers and teacher trainers, as well as other relevant stakeholders, often at the regional level, and to implement curricular reform and initiatives favouring inquiry-based learning (e.g. cross-disciplinary, thematic or project work). In some countries, extra time, funding and smaller student groups enable more hands-on STEM activities in laboratories and outdoors.

Most countries have invested in teacher training in how to use innovative methods, digital resources and tools in STEM teaching, often via eLearning, either for all STEM teachers, or mathematics teachers (as a consequence of students' low mathematics results in PISA) or science teachers only. Large scale in-service teacher training programmes devoted particularly to the teaching of experimental science can also be seen in some countries. Some countries have provided teachers with laptops as a way of increasing their confidence to use ICT based tools in their teaching. The transition from school life to working life is an important aspect of several of the initiatives mentioned in survey responses. One approach is to invite STEM professionals or university students to schools to encourage younger learners' interest, while another is to enable teachers and students to visit STEM work places. In terms of gender-related issues, national policy action plans to ensure equal opportunities for boys and girls across

the education system exist in some cases, and other actions include workshops or summer schools for primary and secondary level female students, a role model approach whereby female STEM teachers are matched to female students, and testimonial websites where STEM professionals share their career paths with students. Some countries have targeted specific STEM areas in their career guidance initiatives, in order to respond to local professional needs.

ICT is valued by all countries for its ability to diversify the learning process and make the study of STEM subjects more attractive. It is considered to have added value for teaching STEM subjects as it facilitates collecting, recording and analyzing data; enables students to carry out safe and quick experiments not otherwise possible in the classroom due to lack of equipment or risk of danger; the simulation and visualization of 3D structures in science; and modelling in mathematics. Although all countries stated that ICT is used in the teaching of STEM subjects, the extent to which this happens in practice varies, owing to the absence of statutory assessment requirements, a lack of computers, teachers' critical attitude, or their unwillingness to change traditional habits.

The majority of the initiatives and reforms identified have only been in place for a limited period of time, and therefore no evaluation is yet available, although sometimes planned. It would be of great value for countries that have not yet planned evaluations of the various initiatives and reforms in place to do so, and those that have, to make the results public when available. This 2011 report interestingly shows that since certain STEM strategies and initiatives were reported on in the previous 2010 report, they have either been extended or new ones have replaced them. Either way, despite government budget cuts, Ministries of Education as well as the private sector are still investing in strengthening the quality of STEM education, in the belief that doing so will inject the growth and innovation Europe so very much needs. We look forward to further information from additional countries to integrate into a regularly updated version of this report in the future. Potential synergies with the work of the European Commission's MST cluster are also to be considered within the framework of European Schoolnet's follow-up of developments in the STEM field.





# Introduction

Since the Lisbon agenda was launched by the European Council in 2000, a lot of attention has been focused on Europe's need to foster a dynamic and innovative knowledge-based economy, not least by producing an adequate output of scientific specialists. In the light of the current economic crisis, this statement has renewed relevance. To achieve this goal we need to increase participation in Science, Technology, Engineering and Mathematics (STEM) studies and careers, especially the number of women. To help Member States achieve this objective, the European Commission established a Maths, Science and Technology (MST) Cluster (a group of countries sharing a common interest in this topic as a national policy priority), in 2006, to facilitate peer-learning and development in this area. Through Peer Learning Activities (PLAs), the voluntary members of this cluster exchange information on different policy options thus helping to advance reform in their own countries. 7 of the 21 countries that answered European Schoolnet's questionnaire on national measures, aimed at dealing with STEM issues, are also members of the MST cluster, namely: Denmark, France, the Netherlands, Norway, Portugal, Sweden and the Slovak Republic. The priorities of this cluster, and indeed of all the countries who responded to the questionnaire, albeit to varying extents, are: modernizing pedagogical methods; enhancing the professional profile of teachers; ensuring transitions from secondary to tertiary level; promoting partnerships between schools, universities and industry; and improving female participation in STEM studies and careers.

This short comparative analysis is based on the voluntary information provided in answer to two questionnaires (available online on the Spice project's website<sup>9</sup>) on national measures to increase students' interest in pursuing STEM studies and careers' sent to all European Schoolnet (EUN) members in October 2009 and August 2011. The first questionnaire disseminated in October 2009 was answered by 16 countries (the Czech Republic, Denmark, Estonia, Finland, France, Ireland, Israel, Italy, the Netherlands, Norway, Portugal, Slovak Republic, Spain, Sweden, Switzerland, and Turkey). It mainly consisted of open questions and was organized in two sections: Part A concerning national measures; and Part B concerning STEM priorities at European/international level, and related initiatives developed by countries. The follow-up questionnaire disseminated in August 2011 was answered by 11 countries, of which 6 (the Czech Republic, France, the Netherlands, Portugal, Slovak Republic, and Turkey) provided new and/or updated information regarding the initiatives and reforms they had already reported on in their contribution to the preliminary 2010 report<sup>10</sup>, and 5 new countries (Austria, Belgium (Flanders), Lithuania, Romania and Slovenia) provided information for the first time. This follow-up 2011 questionnaire consisted of four sections: Part A: STEM priority issues at national level; Part B: Current and future STEM initiatives; PART C: Role of ICT in STEM teaching and learning; and Part D: Industry-school partnerships. Relevant references to international and national reports, evaluations, policy strategy documents, manifestos and websites are provided in English<sup>11</sup> where possible, and if not available, in the original language indicated. Where appropriate, the analysis has been supplemented with extra information provided in the European Commission's MST Cluster reports<sup>12</sup>. At the time of this report going to press, Eurydice has also just published two extensive studies on science and mathematics education in Europe, which because of time constraints could not be compared and cross analyzed with the information provided in this current report. This current report focuses on describing examples of initiatives taking place in each country from a comparative perspective, and does not provide an exhaustive list. The report consists of the following 7 sections: global STEM national strategies, dedicated centres to improve the quality of STEM teaching, curricular reform and inquiry based learning, strengthening teacher training and professional development in STEM, guiding students towards STEM careers, increasing the participation of women in STEM careers, and the role of technology in the STEM agenda.

Issues related to the teaching of STEM subjects were considered of highest priority by most countries, when asked to rate in order of importance a series of STEM issues (based broadly on the concerns listed above of the MST Cluster).

It is interesting to note however, that 4 of the 21 countries surveyed (Austria, Finland, Slovenia and the Slovak Republic) no longer consider STEM-related study and career issues, in the holistic sense, as an educational priority at national level. For example, Finland has not considered STEM-related educational issues as important priorities since 5-8 years ago, when they had dedicated national pilot projects and policy reforms in this area. Now, like the Slovak Republic, Finland is concentrating on other priority areas, including the teaching and learning of foreign languages. Although STEM as a group of subjects is not considered a priority in the Slovak Republic, the teaching and learning of ICT is. The Slovak recent curricular reform has given more teaching time to Informatics than ever before, so that it is now taught as a compulsory separate subject in primary and lower secondary education, and there are special training programmes to increase teachers' ICT competences. Slovenia also does not consider STEM as a priority area at national level, but like the Slovak Republic, does have a clear focus on improving the integration of ICT in the curriculum, teaching and learning. As a small country, Slovenia does not seem to be in particular need of more engineers or other STEM professionals, and so is not making any efforts to change students' current trends in choosing alternative career paths as economists, business managers and lawyers. Austria also does not rank STEM amongst its top educational priorities, but like the above mentioned countries, does place great importance on the integration and use of ICT for the teaching and learning of 21<sup>st</sup> century skills, as evidenced by its *efit21 - digital agenda for education, art and culture*.





Every year the *Beta Techniek Platform* reports progress in this area in its publication '*Facts and Figures*'. The 2011 publication reported the following results: 32% increase since 2000 in STEM studies enrolment at higher education level; 80% increase in the enrolment of girls in STEM education at secondary level (HAVO/VWO); and 5,500 teachers and 7,250 prospective teachers at primary level were trained in STEM teaching between 2004 and 2010. The Dutch government is currently developing a new Master Plan. The scope of this Master Plan is broader than the 2009 version and will start with a focus on the top sectors in which industrial partners, research and educational institutions work together. A new 'Human Capital Agenda' will be formulated within the Master Plan, paying particular attention to STEM education. The details of this are yet to be established, as the Master Plan is still under development.

In 2009, the **Belgian (Flemish)** Department of Economy, Science and Innovation, inspired by the Dutch *Beta Techniek Platform* described above, set up a STEM strategy entitled *Actieplan Wetenschapscommunicatie*<sup>23</sup> (Science Communication Action Plan). The Action Plan's main aim is to promote a scientific and innovative culture in all walks of life and ensure a wider participation in the public debate about these issues and their impact on society. The target audience are young people, teachers and the general public. The Department of Economy, Science and Innovation is responsible for coordinating and monitoring the actions involved in implementing the Action Plan, and works in close partnership with a wide range of science organizations which form the Science Information Network<sup>24</sup> (WIN). WIN provides coordination and structuring of the operational framework for its partners and stakeholders and ensures the practical implementation of the Action Plan. The network aims to exchange information and expertise both within the government and all organizations working in the field of science communication in Flanders. Member organizations can publish their activities and projects on the WIN website, and a monthly newsletter keeps all members up to date with each other's latest news. Uniting all actors on a comprehensive platform, allows the expertise in Flanders to be mapped. The Technopolis platform<sup>25</sup> for science and technology, evolving originally from the not-for-profit organization, Flanders Technology International, is central to the Science Communication Plan, by bringing science and technology to the people. The platform mainly targets 8-14 year-olds and their teachers, and involves a large number of partners, including businesses and the media. In 2009 the budget allocated to implement the Science Communication Action Plan was ca. 9.3 million Euros. Since then the amount allocated has decreased yearly, with ca. 7.3 million euros designated in 2011.

**Norway's** similar global, national strategy, *Maths, Science and Technology for the Future (2010-2014)*<sup>26</sup> is aimed at strengthening STEM competence from kindergarten all the way through to a person's working life. Very much like the Dutch approach, Norway's lifelong strategy is intended to increase synergies and cooperation between education and the world of work, so as to positively impact on recruitment to the STEM professions. The strategy's objectives spread across the priority issues shared in part by most European countries, including improving the quality of STEM teaching and teacher training, as well as encouraging gender balance and career choices in this area. Norway's current strategy was developed on the basis of two earlier national STEM strategies (2002-2007 and 2006-2009). According to the evaluation of the first strategy, the more qualified teachers are, the more impact they are likely to have on the motivation and attitudes of students. As a result of this evaluation, the subsequent strategies include indicators to measure to what extent goals are met, and focus on improving teachers' formal qualifications. Through the *National Forum for Maths, Science and Technology*, national and local education authorities, education providers, industry and social partners take a joint responsibility for implementing the strategy and achieving its goals.

**Ireland's** *Discover Science & Engineering (DSE)* programme was developed in response to the key recommendation of the Task Force on the Physical Sciences for a coordinated effort to increase interest in science and encourage young people to consider science as a viable career option. DSE was therefore launched as the national integrated awareness programme for coordinated science promotion in October 2003. DSE brings together many science, technology, engineering and mathematics (STEM) awareness activities that were previously managed by different bodies, public and private. These include STEM career guidance, primary level teacher training and provision of

teaching resources<sup>27</sup>, as well as projects to promote the teaching of specific areas of STEM, such as sensor technology. DSE aims to build and expand on these activities and to deliver a more focused, strategic and quantifiable awareness campaign for STEM. The target audience for DSE includes students at all levels, their parents and teachers, as well as the wider public. DSE also collaborates closely with industry, the media and other relevant institutions. DSE's mission is to contribute to **Ireland's** continued growth and development as a society that has an active and informed interest and involvement in STEM. Its overall objectives are to increase the numbers of students studying the physical sciences, promote a positive attitude to careers in STEM and to foster a greater understanding of science and its value to Irish society.

**Encompassing national approaches, albeit with a narrower scope, can also be seen in France, Israel, Switzerland and Italy, where efforts are invested in school level, formal (and in the case of Israel also non-formal) education, rather than spread out across the lifelong learning span.**

**France** launched a new national action plan<sup>28</sup> for the teaching and learning of science and technology subjects in primary as well as lower and upper secondary education, in January 2011. Some of the plan's main aims include: improving pupils' mathematical attainment and arousing their curiosity for sciences and technologies at primary school level; deepening curiosity for and interest in scientific and technological subjects through cross disciplinary projects at secondary school level; and encouraging both girls as well as boys to take up STEM studies, providing students with better and more comprehensive STEM career guidance, and developing specialized STEM upper secondary schools (*lycées*), at upper secondary school level.

Israel's *Scientific and Technological Reserves* programme initiated by the Ministry of Education is undergoing a pilot in the year 2010/2011 whereby students participating follow the normal school curriculum with an additional supplementary programme focused on strengthening and enriching the mathematical, scientific and technological content of the existing curriculum. The aim is for the programme to reach 25% of secondary school students in order to help resolve the problem of a relatively small share of students in Israel excelling in science and technology, limiting the country's competitive position on the global map. Schools taking part in the programme receive extra budget for employing the additional teachers/hours required, providing training for the participating teachers, and extracurricular activities taking place outside of school and other enrichment initiatives included in the programme. The programme aims to detect and challenge students with potential to excel in the STEM area as early as possible; target students with lower socio-economic backgrounds by giving them equal opportunities; and encourage girls to participate particularly in the areas of physics and technology. Concretely, the programme's goals are to: increase the number of students who receive a baccalaureate with a strong science-technology component by roughly 78% and reach 25,000 such students in five years; to increase the share of students who receive a quality baccalaureate of science-technology by 100% and reach 18,000 such students in five years; and to increase the share of students who receive an excellent baccalaureate of science-technology by 100% and reach 6,000 such students in five years. Examinations are an integral part of the programme, and students wanting to continue on the programme must receive grades which are one standard deviation higher than the national average in relevant curricular subject examinations. The programme has a national scope, but will initially prioritize the regions of the North, South and Jerusalem as they have a larger proportion of disadvantaged students. Every school which applies must have a good quality ICT and science infrastructure, be recognized by the Ministry of Education and owned by a local authority or non-governmental organization in order to qualify for the programme. Once the pilot is complete, the current programme will be extended until 2016.

**Israel's** *Young Friends of Science*<sup>29</sup> initiative is a framework for cooperation between the higher education sector and the Ministry of Education focused on non-formal education in science and technology. Several activities, including after school classes, out of school seminars during school time, special projects and research workshops as well as summer camps<sup>30</sup>, are all offered in any topic or subject within the STEM area to secondary school students. These activities take place at the units for *Young Friends of Science* at participating universities, colleges and

research centres. The overall aim is to increase students' interest in STEM studies and professions by establishing direct contact between school students and expert universities and research centres specialized in the field.

In **Switzerland**, a policy measure for the Promotion of young scholars *in the fields of maths, science and technology* has been put in place (2008-2011). This policy measure focuses on private-public partnerships between the education sector and industry<sup>31</sup> and is meant to bundle various existing initiatives, create synergies between projects and boost new initiatives for the promotion of STEM careers. The policy measure is intended to address Switzerland's lack of skilled workers in industry, particularly in the field of ICT. The majority of Swiss students opt for non-STEM based studies and careers, with a very small proportion of women choosing to pursue technically oriented professions. This measure aims to involve teachers, teacher trainers, industry and particularly women in innovative partnerships to promote STEM careers. Through the measure's *Matching Platform MNT* partners can communicate and exchange information regarding initiatives aimed at the promotion of young scientists.

To tackle STEM issues on a national scale, **Italy** has set up an *Inter-departmental working group for the development of a scientific and technological culture*. The working group was established in 2006 on the basis of an agreement between 4 state Ministries: the Ministry of Education, the Ministry of Universities and Research, the Ministry of Cultural Heritage, and the Ministry for Reforms and Innovation within Public Authority. Its mission is to support and enhance Italy's scientific and technological culture, and like the Dutch, Norwegian and Swiss approaches places a strong emphasis on the need to foster public and private partnerships within education. Indeed, one of its initiatives has been to introduce a competition aimed at improving pupils' scientific competencies, in which networks of schools have to work in partnership with universities, museums and research centres using interactive didactics. Among its tasks also, are the definition of structural actions for schools<sup>33</sup> and society at large, and providing support for teacher training and the development of ICT within the curriculum. The working group focuses on teachers and students from primary school through to the end of secondary school, and is concerned with all STEM subjects within the curriculum.

## 2.1 Centres focused on supporting and improving STEM teaching

The **Norwegian Centre for Mathematics Education** (set up in 2002) and the *Norwegian Centre for Science Education* (set up in 2003), support schools and other stakeholders by implementing initiatives focusing on the curriculum, equality and outreach activities, developing teaching materials and training, and producing and maintaining magazines, websites, annual conferences and seminars for teachers. The mathematics centre has a network of resource teachers, while the science centre has a network of ambassadors involved in the in-service training of science teachers. The science centre also has a major focus on research in science education, and this research feeds into the in-service training and support offered by the centre to teachers and schools.

In **Belgium (Flanders)**, the RVO-Society<sup>35</sup> is a not-for-profit organization which acts as the gate between research and education in the areas of technology and science learning. The RVO-Society develops educational materials related to the latest developments in science and technology, and provides in-service teacher training and professional development for teachers. Partnerships between schools, companies, universities and research centres are actively fostered by the RVO-Society's work.

**Sweden** has 4 resource centres<sup>36</sup> for teachers, funded by *Skolverket*, the Swedish National Agency for Education, which each focus on a different area in the STEM field (Physics, Chemistry, Biology and Technology). The resource centres provide in-service teacher training, various teaching materials, newsletters, conferences and other relevant pedagogical resources.



The **Dutch** Freudenthal Institute for Science and Mathematics Education<sup>37</sup> (Flsme) aims to improve education in the fields of arithmetic, mathematics, and the sciences, with a focus on primary, secondary and vocational education. The Institute contributes towards this aim through research, teaching, curriculum development and other services.

In **Switzerland** the MINT (*Mathematik, Informatik, Naturwissenschaften und Technik*) Learning Centre at the Swiss Federal Institute of Technology (ETH) was established in 2008 to develop teaching methods, learning objects, programmes and curricula for the teaching of non-life sciences throughout primary and secondary education<sup>39</sup>. Its mission is to develop quality teaching material and methods for teachers from primary and secondary schools, as well as vocational institutions, to improve students' applied knowledge of these subjects and prepare them for science-based studies and professions. In-service teachers develop new tools and then test them in their schools, providing feedback to improve the centre's outputs. Collaboration with science and technology foundations as well as industry takes place when relevant.

Even more recently, in 2009, **Denmark** has set up a similar *Centre for teaching Science, Technology and Health*, which is larger in scope by targeting all STEM subjects and age-groups from kindergarten to university. The centre plans to collaborate with private and public companies, universities, museums and other relevant science centres, as well as schools, and to develop a network of relevant partners. Denmark's national centre is intended to be a central resource hub to collect, coordinate and spread best practice in STEM teaching, and is aimed at improving the quality of teaching in this field and attracting more students to STEM careers. *Naturvidenskabernes Hus* (House of Natural Sciences or NVH) is another newly opened science center which develops tools and techniques for science teaching, intended to motivate students to pursue further studies and careers in the STEM field. This centre also provides in-service training for teachers and facilitates contact between schools and companies, in order to build partnerships.

## 2.2 Centres, campaigns and competitions to popularize science at the level of society

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**Other dedicated centres also exist in the Czech Republic, Portugal, Spain, the Slovak Republic and Denmark, and although the improvement of STEM teaching is part of their goal, their focus is more on the popularization of science at the level of society, to ensure that every citizen is aware of its relevance so that it can become an integrated part of culture.**

The **Czech Republic's** IQ Park<sup>40</sup> and TECHMANIA are both centres with various interactive ICT instalments, aimed at popularizing science and technology for everyone, particularly children. Additionally, the Czech Ministry of Education's initiative entitled Support for Technology and Science Fields (<http://ipn.msmt.cz>) also aims at popularizing STEM subjects, to increase their take-up for further study at university and other higher education institutions. The project has three major pillars of activity including motivational activities, science communication and teacher support. The project provides methodological support for teaching science and technology education, promotional materials, as well as analyses and case studies presented at conferences, seminars, workshops, and promotional talks. In addition to the Ministry's efforts in popularizing STEM, there are various private organizations and NGOs that support students' extra-curricular activities<sup>41</sup> in the STEM area.

**Portugal's** *National Agency for Scientific and Technological Culture, Ciencia Viva*, was set up in 1996 to promote public awareness of science and technology. The agency organizes work experience placements for secondary students in science laboratories, a Science and Technology Week, debates with scientists and other awareness raising events and activities for the general public, including summer courses entitled "Astronomy in the Summer", "Geology in the Summer" and "Biology in the Summer". It also has a special school programme to support and



stimulate the use of experimental teaching methods including the hands-on teaching of science, and to help schools with the practical activities involved in their science and technology projects.

Similarly in **Spain**, FECYT, the *Fundación Española para la Ciencia y la Tecnología* which belongs to the Ministry of Science and Innovation, co-funds various activities developed at the local, regional and national level through a call open to schools, museums, city councils, research centres etc. Examples of funded activities include the regional fairs, such as *Madrid es Ciencia* which involve schools participating as visitors, as well as exhibiting their own school experiments. Like in Portugal, Spain also has a *Semana de la Ciencia* (Science Week), initiated by FECYT and implemented regionally by each Autonomous Community.

Similarly, the **Slovak** Academy of Science has a Science and Technology Week campaign which takes place annually in November, in conjunction with the conference about teaching and learning science and technology in secondary schools and the competition *Scientia Pro Futuro*<sup>42</sup>. Since 2007, the Ministry of Education, Science, Research and Sport has been organizing the Science and Technology Week in cooperation with the *National Centre for the Popularisation of Science and Technology in Society* annually. Moreover, the Science and Technology week is part of a global strategy for the Popularisation in Society of Science and Technology<sup>43</sup>, approved by resolution of the Government of the Slovak Republic. In addition to the Science and Technology Week, the *National Centre* organizes conferences, workshops, public discussions, exhibitions and fairs. Since 2008, on a monthly basis, it also arranges informal meetings called Science in the Cafeteria in four cities, where the general public have the opportunity to discuss and ask questions to science experts. Since 2009, such monthly meetings now also take place between science experts and 12-20 year-old students, in two of the country's major cities.

The Ministry of Higher Education and Research in **France** organizes an annual dedicated week called *La fête de la Science*, which consists in the organization of workshops, exhibitions, visits to laboratories and industrial sites, meetings between researchers and young learners, as well as debates and conferences. France has also combined two of its cultural science centres, *Cité des Sciences* and the *Palais de la Découverte*, to establish *Universciences*<sup>44</sup>, a public institution offering the general public information and the elements for understanding today's scientific research and innovation, and their impact on society. *Universciences* also has an Education department.

**Denmark's** *DanskNaturvidenskabsformidling*<sup>45</sup> (Danish Science Communication) founded by the Ministry of Education and the Ministry of Science, Technology and Development, is also focused on popularizing science and stimulating interest through its public science events, and the Danish Science Week, involving roughly 40% of Danish schools. The board of this organization consists of leading national representatives from universities, industry, schools, science centres and local governments.

**Ireland's** *Discover Science and Engineering* programme also organizes in cooperation with education, public, business and regional partners a Science week<sup>46</sup>, a Maths week<sup>47</sup> and an Engineering week<sup>48</sup>, which are national events gathering between 25- to 100,000 participants each year. Additionally, *Discover Science and Engineering*, together with Intel and 14 Institutes of Technology are partners in *SciFest*<sup>49</sup>, a local one-day science fair held in all 14 regional Institutes of Technology and open to all secondary students. The *SciFest* fair includes a competition and exhibition of projects, a selection of science talks, science demonstrations in the college laboratories and a prize-giving ceremony. *SciFest* aims to encourage a love of science through an investigative project work approach to learning and to provide an opportunity for students to display their scientific discoveries. This national initiative began as a pilot in 2008 and is now an established promotion event of secondary level project work, currently involving 196 secondary schools across the country, displaying 1,097 projects from 2,649 students, and continuously growing. Preliminary evaluation testifies to 99% of students believing *SciFest* to be a "worthwhile learning experience".

In most countries surveyed, there is a specific effort to popularize STEM subjects and professions through campaigns and dedicated STEM weeks as described above, or also through competitions, described below.

In **France** there are various competitions for school students which are particularly characterized by their public-private partnerships approach, bridging the education and industry sectors. For example, *Course en Cours*<sup>50</sup> (Race Course) is a contest organized by Dassault Systèmes and Renault, in partnership with the National Ministry of Education, Université de Versailles Saint-Quentin-en-Yvelines, and the youth magazine Science & Vie Junior. It is a collective challenge which allows teams of secondary pupils, supervised by their teachers, to conceive of, manufacture and promote a mini-racing car, with the help of a university student tutor. The competition therefore relies on a tight partnership between the school community, the academic world and industry, and is aimed at encouraging students to take up vocations in the scientific and technological fields. The initiative began in 2006, and in the period 2010-2011, 2, 200 teams, 11, 500 pupils and 650 university student tutors participated in the competition. During the process, teams have access to the necessary equipment provided in a resource centre based at a university in the participating Académie, which acts as a place of exchange for secondary pupils and their student tutors from the local universities. At the end of each year each team presents two cars at the Finale France event, to a jury of 260 professionals and 13 prizes and trophies are awarded. The success of this competition has been its ability to provide teachers with a motivating pedagogical tool.

In 2007, the national academic geoscience olympiad competitions were created by the Ministry of Education, within the framework of the international year of planet earth, and in partnership with the *Académie des Sciences, Muséum national d'Histoire naturelle* and *Planète Energies* (an initiative of the company Total). The aims of the competitions are to develop secondary students' appetite for science; encourage the emergence of a new scientific culture around the geosciences; highlight the multidisciplinary dimension of geosciences; and emphasize the close link between the geosciences and the range of occupations associated to them. Through a contest open to all lower secondary students who wish to voluntarily present an innovative project, the Fondation C.Génial has taken action in schools to boost the relationship between young people and science since 2008. Projects are conducted in partnership with the world of research and enterprise, and involve collaboration with various STEM professionals, including scientists, researchers, engineers, and technicians. France, like **Romania**<sup>51</sup>, also participates in the *European Kangaroo Contest of Applied Mathematics*. There are also competitions for secondary level students in France called *les Olympiades de mathématiques, de physique, de chimie*.

The **Czech Republic** has similar competitions also called 'the Olympics' in all STEM subjects, organized by the Ministry of Education, Youth and Sports annually, and open to all primary and secondary schools.

Likewise, the **Romanian** Ministry of Education, Research, Youth and Sports, in partnership with the Scientific Society of Mathematics, Chemistry, and Physics, and the local Inspectorate, also organize *National Olympiads*<sup>52</sup> in STEM subjects, covering mathematics, physics, chemistry, biology and IT. The aim is to encourage talented students to participate in the competition at national level, and then prepare them to compete at international level.

The **Slovak** Ministry of Education also organizes STEM competitions for students, as do other associations in the Slovak Republic. These include the annual problem-solving National Olympiads<sup>53</sup> for secondary students initiated by the Ministry of Education in partnership with scientific associations, in informatics, mathematics, physics, chemistry, biology and geography. The *Olympiads* are run at school, regional and national levels. Slovak students also participate in the international STEM Olympiads. The Slovak Republic also runs *Correspondence Competitions* for secondary students in mathematics<sup>54</sup>, physics<sup>55</sup> and computer programming<sup>56</sup>. These competitions are aimed at curious and talented secondary students to motivate them to carry out small personal inquiries outside the scope of typical text book problems. Each competition consists of three rounds distributed throughout the school year. In the course of each round students are given a set of challenging mathematical or physical problems, which they can solve during the following three weeks. Afterwards the solutions are sent to the organizers either by post or

email, and are corrected. Each participant then receives personalized comments to his/her solution together with the solution proposed by the author of the problem and a new set of problems. The winners of the competition are awarded prizes (typically books and brain-teasers) and are invited to participate in winter and summer learning camps. These annual competitions receive financial support from the Ministry of Education, and are managed in partnership with the Ministry's agencies or NGO's. The competitions were interestingly however initiated by higher education staff and STEM students. The competitions are carried out at national level and typically involve 300 students per round in the mathematics competition, 150 students per round in the physics competition, and 100 students per round in the programming competition.

Delfin<sup>57</sup> (2009-2013) is the name of another national *Correspondence Competition* which works in a similar way, but focuses on engineering and technology in addition to the other STEM subjects, and is aimed at upper secondary students only. The aim of the measure is to provide students with interesting real-life STEM problems to bridge the gap between abstract textbook knowledge and everyday situations, and to emphasize interdisciplinary connections between the separate STEM subjects, and enable students to compare themselves with other students throughout the country. This competition was initiated by a not-for-profit organization (P-MAT n.o.) and is currently funded by the Ministry of Education's Research and Development Agency. Finally, *Bobor*<sup>58</sup> (beaver) is a one day informatics competition for pupils of all ages, available online since 2007. The competition was initiated by the Comenius University and Microsoft and PC Revue sponsor the awards. At national level 22, 139 participants took part in 2010-2011, and internationally there were 234, 739 participants from 13 countries in the last year.

**Portugal** also has Olympiad STEM competitions. *National Physics Olympiad* and *National Chemistry Olympiad* are annual competitions for secondary school students, promoted by Physics and Chemistry scientific organizations with the support of the Ministry of Education. Portuguese students, like Slovak students, also participate in the *International Physics Olympiad* and *International Chemistry Olympiad* with national delegations selected through the respective competitions mentioned above. Since 2009, the Portuguese Ministry of Education has also actively promoted students' participation in the European Union Science Olympiad (EUSO), in partnership with physics, biology and chemistry associations. EUSO is a team competition for European secondary school science students who are 16 years of age or younger on December 31st, prior to the competition. Students' skills in tackling science problems and conducting scientific experiments are tested in an integrated way. This competition aims to challenge and stimulate gifted science students to develop their talents and kick-start their careers as scientists, and provide them with an invaluable experience which may motivate them to take part in the International Science Olympiads. At a more general level, the competition enables students and teachers to compare the syllabi and educational trends in science education within the EU member states, with the aim of helping to improve science education at national level. Another competition which takes place under the protocol of cooperation between the Ministry of Education and the Youth Foundation allows students of basic and secondary education to submit research projects in the areas of biology, chemistry, geology, economy, engineering, environmental science, computer science, medical computer science, mathematics and physics. The jury who evaluates the projects submitted is set up by the National Agency for Scientific and Technological Culture, and comprises of professors and scientists of recognized merit in the above mentioned areas, as well as professionals from the Agency, Ministry of Education, and Youth Foundation. The number of participants taking part in the competition is increasing every year, as is the quality of the research projects submitted by schools.

**Israel** also has 11 of its own *OlimpiYeda* STEM competitions for secondary school students, including 5 international<sup>59</sup> and 6 national<sup>60</sup> ones. Between 3- and 6,000 secondary students take part in each of these competitions. The purpose of these competitions is to develop motivated students' awareness of the importance of these scientific areas of knowledge and to provide them with an opportunity to deepen their learning in an informal framework. The preparation for these competitions takes roughly a year and learning resources are developed which are later used to enrich the formal curriculum of the education system.

In **Estonia**, their national *Competitions for Young Scientists* and Inventors are used as a way to encourage students' creativity and motivate them to design innovative products and processes.

In **Finland**, various annual STEM competitions are set up by universities and other organizations, and supported by the Ministry and National Board of Education. One example is *Tämä Toimii (This Works)*, which is a design competition for young children organized annually by the Federation of Finnish Technology Industries.

## 2.3 Local specialised centres and municipalities

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**In addition to their national centres Norway, Portugal, Sweden, the Czech Republic and Denmark have set up other bodies to promote the study and development of STEM teaching at a more local level. Ireland, Israel, and Austria have also established local centres spread across the country to spread the development of a scientific culture.**

In **Norway** 7 science centres have been set up across the country's different regions to support the work of the national *Norwegian Centre for Science Education*. The regional science centres show a significant and steady increase in popularity, with visits having more than doubled since 2003. According to preliminary results from the Norwegian Centre for Science Education's research project *Vilje-con-valg*, 20% of all students enrolling in tertiary STEM education in 2008 indicated Science Centres as an important motivating factor, above career guidance provided at school and media campaigns.<sup>61</sup>

A similar approach has been implemented in **Portugal** where the *Ciencia Viva agency* has set up a national network of 17 interactive science centres with the aim of promoting a scientific culture and improving the awareness and interest of citizens of all ages. The science centres, conceived as interactive spaces, provide the opportunity for scientific, cultural, and economic regional development. In-service training courses are organized to show teachers how they can use the centres to support their science and technology teaching.

**Ireland's** Discover Primary Science programme coordinates 27 *Discover Science Centres* across the country. These centres are used for school and family visits for their informative, interactive and fun nature. The *Discover Science Centres* community have access to an online forum for discussion and information exchange, and the centres develop various online teaching resources connected to specific topics in the curriculum, covering the areas of living things, energy and forces, materials, and environmental awareness and care.

**Sweden** also has a series of regional science centres<sup>62</sup> which have been receiving government grants since 1997. 14 such science centres received state funding in 2009. The science centres are targeted at teachers, students and the wider community and are committed to spreading knowledge and stimulating interest in the STEM field. There are special educational programmes designed for teachers available at the centre, attended by several thousand teachers across the country each year. Many of the centres also arrange outdoor visits and outreach activities to motivate new audiences and the wider public.

**Israel's** Ministry of Education, the National Lottery and the Center for Local Government have jointly established 80 *Pais Clusters for Science, Technology and the Arts*<sup>63</sup> across the country and located near to lower secondary schools. They are community centres which act as learning environments rich in tools for investigation and opportunities for live experiences enabling active and independent learning in the science and technology laboratories available. They can be used within school time as well as for leisure for the benefit of the whole community. The centres allow for multidisciplinary and interdisciplinary investigative learning in 5 multi-purpose laboratories. The students develop innovative projects and there are learning circles, workshops, and ICT based activities. The clusters also serve as in-service teacher training centres.

The **Czech Republic** has a network of special hobby centres for children and young people, set up by local authorities, offering a variety of STEM interest groups (such as an ICT club, a programming club, a biology and chemistry club etc.) in almost all Czech towns.

**Denmark** has taken a more structured and thorough approach by implementing a local strategy whereby 25 of its 98 municipalities have since 2008 become *Science Municipalities*. Each of these *Science Municipalities* has a mission to strengthen the study of science with the help of a local tailored strategy, science board, coordinator etc. These Science Municipalities are intended to strengthen Denmark's scientific culture by building bridges between compulsory education, post-compulsory education and private and public companies. This initiative has been based on a pilot project (2003-2007) involving one municipality, and is being continuously evaluated by researchers in science didactics, at the University of Copenhagen.

**Austria** has also opted for a comprehensive regional approach in its attempt to improve the quality of STEM teaching. As a response to Austria's dissatisfactory results in students' mathematics, science and reading skills in the international PISA and TIMSS tests, the Federal Ministry of Education, Arts and Culture commissioned the Institut für Unterrichts und Schulentwicklung (IUS) (Institute of Instructional and School Development) to plan and implement the formerly called Innovations in Mathematics, Science and Technology Teaching (IMST) project. Since 2010, the project has been extended to focus on the teaching of ICT and German also, and consequently the project's abbreviation IMST has come to stand for *Innovationen Machen Schulen Top*<sup>64</sup> (Innovation Makes Schools Top). The project began in 1998-1999 when the data of the international tests was analyzed, and the points of concern identified were low student achievement, poor class work, and low interest in mathematics and science subjects as well as in related studies and professions. This was followed up in 2000-2004 with a development phase which targeted the problems found in the analysis, at secondary school level. As a result of the development phase a support system was constructed and implemented over two periods: 2004-2006 and 2007-2009.

The IMST support system implemented the following key measures: upgrading the role of local and regional subject coordinators to local and regional managers; setting up regional centres for subject didactics and school development; setting up new or upgrading existing regional networks; setting up national subject didactics centres; setting up a fund for and *Institute of Instructional and School Development (IUS)*. In all nine Federal Länder, regional networks have been set up, in addition to five district networks to support the regional educational structures. A total of 18 regional centres for subject didactics are active at universities and teacher education colleges. Moreover six *Austrian Educational Competence Centres (AECC)* – with subject didactics centres for biology, chemistry and physics (in Vienna) and for German studies and mathematics (in Klagenfurt) – as well as the cross-subject Institute of Instructional and School Development (IUS, Klagenfurt and Vienna), have been put in place step by step, starting in 2004. The fund for instructional and school development has supported 861 classroom and school projects since 2004. Approximately 1,800 teachers have been actively involved in the projects, which has impacted on roughly 40,000 students.

Today IMST continues its work to structurally anchor a culture of innovation to consolidate exemplary teaching in mathematics, information technology, science, German studies, and technology. During 2011 and 2012 regional networks will continue to be supported under a network programme. By way of regional educational planning these networks can set their own priorities and support district networks, regional specialist didactics centres, specialist groups in schools and/or inter-school networks. This programme also permits the setting of contextual priorities by promoting small-scale projects, for example. Network events provide opportunities for experience exchange as well as for structural upgrading and the dissemination of knowledge and experience gained. As of 2010, IMST has started supporting five to ten theme programmes for classroom and school projects with a view to boosting specific priorities, including competence in mathematics and science class work. The network and theme programmes are monitored by programme teams, composed of academics at universities and colleges of teacher education as well as school staff, which work on approximately 20 classroom and school projects per theme and school year. Thanks to IMST's



support system, the way has been paved for further anchoring of specialist didactic knowledge so that educational policy projects can resort to reliable structures. The Austrian Educational Competence Centres for example, have turned out to be key agents in the introduction of educational standards and of a centralized secondary school leaving exam. It should be noted that special attention is paid to gender equality throughout the IMST project, ensured by its *Gender Network* which feeds into both the content and structure of all IMST activities, and is reported on in section 6 of this report.





## Curricular reform and inquiry based learning

**The majority of countries that replied to the questionnaire mentioned that national curricular reform impacting on STEM subjects has recently taken place, or is currently or will be soon taking place at primary and/or secondary level.**

**Israel** is beginning in 2010/2011 to revise the science and technology curriculum of primary schools, with the purpose to clearly define the knowledge and skills every student should acquire by the time he/she finishes the final year of primary school. Moreover, the science and technology curriculum for lower secondary students is also being updated and schools are being given more resources to deal with the requirements of this new curriculum beginning in 2010/2011, and eventually to be applied fully to all schools. Despite official recommendations, less time is usually spent by schools on teaching the science and technology curriculum than is suggested. For this reason the Ministry of Education has increased the allocation of weekly teaching hours for science and technology with a minimum of 4 hours per week in the 7<sup>th</sup> grade and 5 hours per week in the 8 and 9<sup>th</sup> grade. An important aspect of the newly revised curriculum is that science and technology will be taught in the laboratory with groups of no larger than 28 students. For this purpose each two classrooms will be divided in three groups and schools will receive an additional budget to cover for the of 2.5 additional teaching hours required by the third group.

A new curriculum framework<sup>65</sup> for primary and lower secondary education was introduced in **Lithuania** in 2008, and has been implemented in schools since 2009. The STEM programmes of study are focused on inquiry-based learning and the integration of ICT in teaching and learning. They also pay particular attention to the socio-economic aspects of science and career guidance. To support the implementation of the new curriculum Lithuania's *Education Supply Centre*<sup>66</sup> has prepared a *School Improvement Programme (SIP Plus)*, and EU Structural Funds and common financing funds are being used for the programme's implementation. Seven projects are currently running under this programme, one of which being the "Technology, arts and science infrastructure" project, involving schools receiving computers, smart boards, multimedia projectors and computer laboratories. Lithuania's *Education Development Centre* has also planned to implement a renewed curriculum dissemination model from 2012-2014, by adapting deficient computerized educational tools or creating new ones for various subjects at lower and upper secondary level, including science, technology and mathematics.

The *Education Development Centre* is also currently implementing the project "*Providing Wider Possibilities for Students aged 14-19 to Choose a Learning Pathway. Phase II: Deeper Learning Differentiation and Individualisation for ensuring Educational Quality demanded by today's World of Work*"<sup>67</sup> (2008-20013). The project aims to widen students' learning pathway choices by individualizing and differentiating the curriculum, expanding students' study and career options, making the curriculum more attractive and in line with the demands of the modern labour market, and developing participating students' professional competences. The project involves designing model guidelines for modular programmes, and methodological tools for enterprise and employment development to be used by teachers, school administrators, education specialists and consultants, developed in cooperation with industry. For example, videos of professionals at work have been produced, highlighting their professional skills and personal qualities needed for their chosen profession, and the career opportunities open to them. The development of such guidelines and recommendations will increase access to training for students with various interests, needs and skills, allow for the individualization of training, decrease students' training workload, as well as permit students to apply their knowledge in practice and plan their careers. The intention is to help decrease the number of early school leavers. The project is in the process of developing the new education organization model

offering more choice to students according to their needs, strengths and abilities, and is designing and testing the module guidelines in the following subject areas: Lithuanian, Mathematics, History, and Sciences (Biology, Chemistry and Physics). A new Arts education programme is also planned, and methodological recommendations on the use of ICT in teaching are also being drafted for Art and Technology teachers, including the use of video and audio materials. In the coming years, the project will seek to learn from foreign countries with advanced experience in this area, by inviting experts to join international cooperation networks.

Thanks to the **Danish** upper secondary school curricular reform of 2005 (focusing more on competencies than content) the role of cross-disciplinary work is developing in importance in the teaching of STEM subjects.

Trans-disciplinary work is also the focus of the **Romanian** project. The educational process optimized vision of skills for the knowledge society<sup>68</sup> (2009-2012). The pilot programme is funded by the European Social Fund, and implemented by the Ministry of Education, Research, Youth and Sports in partnership with the software company SIVCO Romania SA. It aims to use a trans-disciplinary approach together with multi-touch technology, to increase student interest and motivation in studying STEM subjects. Teachers and students create teams to share and exchange knowledge, skills and creative solutions on various STEM related themes, to enhance trans-disciplinary learning. The main goal is to improve the educational process by developing part of the school curriculum in a trans-disciplinary manner, including the development of teaching materials for science and humanities subjects at secondary school level, based on students' development needs and taking into account national quality standards. This trans-disciplinary project ties in with Romania's more general re-organization of the National Curriculum<sup>69</sup> and its referential framework<sup>70</sup> for secondary education (2009-2012), initiated by the National Assessment and Examination Centre, in partnership with the Ministry of Education, Research, Youth and Sports, where inquiry-based learning and cross-curricular work play a central role.

In **Turkey**, a new science curriculum has been designed to integrate constructivist and student-centred learning. ICT-based laboratories with hand-held computers and sensors have been built in secondary schools, and teachers are encouraged to use simulations to enhance STEM learning. These new tools and methods support the constructivist characteristics of the revised science curriculum. These developments have been largely influenced by the research conducted in recent years by TÜBİTAK<sup>71</sup> – the *Science and Technological Research Council of Turkey*, which specifically promoted the benefits of using ICT in education. These educational policies can be seen to feed into the country's *National Science, Technology and Innovation Strategy (2011-2016)*, despite school education not being explicitly mentioned. ÖBBS<sup>72</sup> is the name of the national exam which monitors students aged between 8 and 16 years-old in terms of their mathematics and science skills. Beyond this, the Council's Vision 2023 project has as its main goal the task of creating a society which is competent in science and technology; uses technology consciously and is capable of developing new technologies; and possesses the skills needed to convert technological developments into social and economic benefits.

The **Swedish** government is currently reforming the curricula for compulsory level schooling in the Skola 2011<sup>73</sup> reform for students aged between 7 and 16 years old and for upper secondary level schooling in the GY 2011<sup>74</sup> reform for students aged between 16 and 19 years old. The upper secondary curriculum reform is based on recommendations given in the government's report entitled '*Higher standards and quality in the new secondary schools*'. The report states that each course should clarify what content is essential and therefore should be covered in class teaching. This will create fairer conditions than are currently available, as assessment will be strictly based on the content covered in lessons. These reforms are accompanied with the implementation of a new grading system for assessment purposes. All subjects are concerned, including mathematics, physics, biology, chemistry, technology and general science studies. The overall intention is to create curriculum syllabuses with a clearer structure and coherence, and to raise pupils' interest and achievement at school. The new curriculum will come into force in the autumn term of 2011.

**Switzerland's** ongoing *Bildungsstandards* inter-cantonal project<sup>75</sup> aimed at harmonizing cantonal school curricula has also given a special priority to STEM subjects.

**Finland** has recently set up a working group proposal for a renewed curriculum. All curriculum subjects will now be part of one of six clusters, including one cluster on mathematics and another comprising all remaining STEM subjects. The importance of using technology will also be more present in the teaching of all STEM subjects.

In **Ireland** key curriculum developments include the re-introduction of science teaching in primary schools in 2002, the introduction of points for science project work in the Junior Certificate in 2006, and the piloting of project work in Maths fostering a more inquiry based approach from 2008 which commenced its full roll out to all secondary schools in 2010.

As part of the national Mathematics Action Plan, a new Mathematics Programme for Basic Education<sup>76</sup> is being implemented, concerning students aged 6-15 years-old, in grades 1-9. The new programme involves the reorganization and definition of goals, mathematical themes, methodological orientations and all aspects related to curriculum management and assessment.

Following the **Czech Republic's** Framework Education Programme for Elementary Education<sup>77</sup> (2005-2008) involving the reform of primary and secondary school curricula, STEM subjects are now taught under thematic headings, such as '*Man and Nature*' (including physics, chemistry, biology, geography and geology) and '*Man and the World of Work*' (including technology). The main idea behind the reform was to make schools more independent from central administration. There is an emphasis in the revised curricula on increasing the pedagogical autonomy of teachers, and supporting them to use new and innovative methods, especially constructivist approaches. In 2010, the Czech Republic also ran a national curricular project called "Literacy Support" covering five areas including mathematics, science and ICT literacy. The project was an initiative of the Ministry of Education and was implemented by its Research Institute of Education. The project which focused on primary education was a reaction to deteriorating results of Czech pupils in the international PISA and TIMSS surveys. The aim of the project was to find out whether the current curriculum adequately supports the development of students' literacy or not. It also aimed to provide teachers with effective methodological support for further development of students' literacy.

In 2011, the **Czech** Ministry of Education, Youth and Sports is currently reviewing the curricula and identifying the minimum requirements for pupil attainment by the end of the 5th and 9th grades in compulsory education. Once this review is completed, nation-wide testing is planned to assess students' level of education at these two moments in their school careers. The test results will form the evidence base for the Ministry's follow-up actions in this area. According to a recent amendment to the school law on reforming secondary school leaving exams, a new version of this exam was launched in the school year 2010/2011, in a slightly simplified state. In 2012/2013 the full version of the new leaving exam will be launched. The new leaving exam will consist of two parts: a 'state' part which will be common to all upper secondary schools in the Czech Republic, and will involve taking a group of compulsory and optional exams; and a 'profiled' part, allowing schools to independently design their own areas of specialism. The compulsory exams will be offered at two levels of difficulty, and students are required to take three exams: Czech language, a foreign language (choice of 5 languages available), and either mathematics, a social science subject or an ICT subject. Additionally, students can choose a maximum of three optional exams, and their result in these exams will have no influence on the result of the compulsory part.

The Czech Republic has also implemented a grant initiative using the European Social Fund, entitled *EU Money to Schools*<sup>78</sup> (2010-2012). It supports various innovative curricular approaches in different areas of teaching: STEM, financial literacy, reading and information literacy, foreign language teaching, inclusive education, and the use of ICT in all subjects. Schools can apply for a grant directly to the Ministry of Education, and the grant can be used, for example, for equipment, teacher training or the production of new learning materials. It is expected that

approximately that two thirds of the whole budget (4, 5 billion CZK i.e. 1,8 million EUR) distributed over the two years will be invested in ICT equipment. The initiative is currently only targeted at primary schools, but a similar grant aimed at secondary schools, and more specifically vocational education, will be available in 2012-2014. This latter grant will focus on making the development of professional competences and STEM literacy in upper secondary education possible. Secondary schools wishing to apply for a grant from the EU Money to Schools scheme will be required to fill in their profile in an online evaluation tool called *Škola 21*<sup>79</sup>. This tool has been available in pilot version since the end of 2010 and has been designed to enable schools to assess their current use of technology and plan for improvement.

**A special focus on inquiry based learning can be seen in the initiatives and reforms mentioned by France, Portugal, Estonia, the Slovak Republic, Ireland and Norway, while in Finland it has since 2004, been a principle underlying all curriculum subjects, including STEM.**

**France's** well known *La main à la pâte*<sup>80</sup> initiative focuses on hands-on science, and has been the basis for the reform of science education in primary and lower secondary schools since 2002. The *La main à la pâte* approach is inquiry-based and gets students to develop hypotheses and experiments to raise interest and motivation for studying the sciences. Students are the key actors and teachers are facilitators. The focus is getting students to investigate real applications of STEM to everyday life. This new approach involves teacher training and thorough evaluation. The *La main à la pâte* initiative also cooperates with numerous countries abroad which are actively involved in implementing this teaching and learning method. At secondary level in France the BAC Professionnel has been shortened to 3 years instead of 4, and accompanying practical training has been reformed so that a thematic approach has been implemented together with an investigative aspect.

In **Portugal** a curricular reform at secondary level affecting students aged 10-15 has taken place whereby extra time for science lessons has been granted to schools so that students can be split into two groups, allowing each group the opportunity to work in the laboratory and do more hands-on activities<sup>81</sup>.

In **Estonia**, a new curriculum is to be launched in 2011, which gives a strong emphasis to inquiry-based learning. Science lessons will be taught in smaller groups enabling more time and teaching resources to be available for hands-on activities, inquiry-based learning, outdoors learning and problem solving tasks.

In the **Slovak Republic** there are initiatives<sup>82</sup> focusing on hands-on science teaching, where the method used involves teaching through projects and asking pupils to solve mysteries. The schools involved in these small-scale initiatives claim that this method of teaching increases pupils' interest in problem solving tasks.

The *Discover Sensors*<sup>83</sup> pilot project in **Ireland** focuses on developing inquiry based learning using ICT. The pilot is being run by the National Centre for Technology in Education and involves the participation of 200 secondary schools.

**Norway's** Natural Schoolbag pilot programme gives schools money to support teachers to teach outside of the classroom, so that more practical, hands-on teaching can take place<sup>84</sup>.



# Strengthening teacher training and professional development in STEM

## 4.1 Online initiatives

Several in-service teacher training efforts are happening via e-Learning.

One such example is the **Italian** national action plan, *Mat@bel*, providing training for mathematics teachers in the format of blended eLearning on the national teachers' PuntoEdu portal. The action plan implemented by the Ministry of Education comes as a direct result of the low performance of Italian students in PISA's mathematics tests. For the moment the training is given only to teachers of 11-15 year-olds, but it will eventually be expanded to all education levels.

Like Italy, **Portugal** has also reacted to Portuguese pupils' low achievement in the international survey PISA by implementing an in-service teacher education programme (only small parts of it online however) for mathematics teachers teaching younger pupils aged 6-11. During 2005-2008 approximately 12,600 teachers successfully took part in the training, which is part of an ongoing programme, integral to Portugal's national Mathematics Action Plan. This Action Plan mainly concerns primary school teachers but also secondary school teachers. It includes several measures: Mathematics Programme - Teams for Success (teams of teachers can apply for their school to receive support teachers to help them implement innovative three-year projects focused on the improvement of students' mathematics learning); the Mathematics Programme for Basic Education (see section 3 on curricular reform); the promotion of professional development programmes for primary and secondary school teachers; the creation of a database of educational mathematics resources; the assessment of school mathematics textbooks; and the reorganization of initial teacher training programmes and access to STEM teaching.

Another example of eLearning for teachers is the **Czech** *RVP.CZ porta*<sup>86</sup>. This portal provides teachers with methodological support for increasing the quality of their teaching. Training and resources for in-service teachers focusing on various subjects including STEM, are offered through various digital tools, including wiki's, digital learning objects and digital portfolios. The portal is being monitored and at present 28% of teachers are using it.

The **Dutch** *Beta Techniek Platform* has introduced a stimulation programme for STEM in-service as well as newly qualified teachers in primary education. The programme aims to reach 5000 in-service teachers and 5000 newly qualified teachers and promotes innovative methods and daily practice examples.

In **Finland**, STEM in-service teacher training is subsidized by the government, and through the *Arithmetic, Science, Technology and e-Learning project (ASTeL)* teaching material for physics and chemistry teacher training is available on the internet.

In **Estonia** there is a national programme running from 2008-2013 to train teachers and school administrators in how to use eLearning and advanced ICT tools in the classroom.



In **Romania**, 13, 000 schools are now equipped with Advanced eLearning (AeL) Learning and Content Management Systems, thanks to the *AeL Educational project*<sup>87</sup>. eLearning tutorials to train teachers to use them are included in the systems.

**Norway's** *Programme for Digital Competence*, which ended in 2008, also focused on improving teachers' e-Skills and providing them with digital teaching resources and new methods of working.

**Ireland's** National Centre for Technology in Education provides primary<sup>88</sup> and secondary<sup>89</sup> school teachers with digital content for teaching STEM subjects.

## 4.2 In-service Teacher Training Programmes

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**The teaching of experimental science has been the subject of in-service teacher training programmes in Ireland, Portugal and Italy.**

**Ireland's** *Discover Primary Science*<sup>90</sup> is a flagship teacher training project under the Discover Science and Engineering national programme. The project is run by a partnership comprising of the Ministries of Education and Enterprise and the Irish National Teachers Organization, with industrial partnerships being developed in 2011. Primary school teachers are provided with training, useful online resources and classroom activity packs. Activities include hands-on induction days for teachers which are hosted throughout the country in colleges of education, institutes of technology, universities and education centres. This training programme began as a pilot in 2005 to support the re-introduction of science teaching in primary schools, helping non science specialist teachers to successfully manage the practical aspects of the exploratory approach used for science and mathematics teaching. The programme is ongoing has evolved into an established network of 4,300 teachers who are provided with support on specific topics (such as mathematics currently in 2010). Over 3,100 primary schools across the country are involved. An annual evaluation to determine the success and future directions to follow takes place. These evaluations have shown that teacher satisfaction has always been high and remains so, and overall participants in the scheme continue to grow. Discover Primary Science also manages the *Awards of Science Excellence*<sup>91</sup> each year. Schools registered on the Discover Primary Science project can opt to apply for an *Award of Science Excellence*. Schools that register for the award must keep a log of their science activities, and accumulate credit for inviting speakers to the school to talk about science, displaying their work and other explorative activities.

Generalizing practical work in school science is one of the **Portuguese** Ministry's main goals to achieve scientific literacy for all pupils. As part of the Portuguese National Action Plan for Science, an in-service primary teacher training programme<sup>92</sup> aimed at increasing teachers' use of experimental work in teaching ran from 2006-2010. The Ministry of Education has commissioned the Educational Research Centre at the University of Aveiro to conduct an evaluation study to assess the impact of the training programme, which is expected to be published by the end of 2011, in Portuguese. The aims of the evaluation study are: to compare science teaching practices before and after the training programme, to identify changes which have taken place; assess the training programme's impact on students' scientific knowledge and skills; analyze the impact of collaborative environments within and between schools; evaluate the use and management of laboratory equipment and materials in schools; and evaluate the impact of the Science Education Guides produced as part of the programme to complement the use of science textbooks in primary schools.

**Italy's** *IIS action plan: teaching experimental science* was a national in-service teacher training initiative promoted by the Ministry of Education in cooperation with the teachers' disciplinary associations, and the Museums of Science and Technology in Milan and Naples, which took place in 2006-2007. The training was aimed at teachers teaching pupils aged 6-16 and concerned all STEM subjects.



**Sweden's Boost for Teachers Initiative**<sup>93</sup>, is a much wider government initiative aimed at further educating teachers and raising their status. The continuous professional development programme within the initiative covers all subject areas, including STEM, and is implemented by the Swedish National Agency for Education, *Skolverket*, in partnership with various universities. It aims to raise the competence of qualified, practicing compulsory and upper secondary level teachers in order to better support students attain their learning goals. Through this continuing professional development for teachers, school organizers have the opportunity of strengthening teacher's competence, both in the theory of their subject and pedagogical approaches to teaching. The organizers receive 56 percent of the cost of a teacher's average salary as a state grant, allowing teachers to receive at least 80% of their salary whilst studying. Both national and international examinations show that students' performance has deteriorated in several areas, and the national evaluation of compulsory school (NU-03), conducted by the National Agency for Education, found it has lowered since the analysis was conducted in 1992 and 1995. This teacher training initiative is therefore based on evidence coming from research and evaluations illustrating that educated teachers with up to date knowledge and skills are a prerequisite for improving student achievement. A survey questionnaire carried out by the National Agency for Education in 2008 shows that the majority of teachers consider they have increased both their subject knowledge and enhanced their pedagogical competence as a result of the programme. Most teachers state that they either have or will be changing their approaches to teaching and learning in STEM subjects (as in others) as a consequence of this professional development. During the period 2007-2011 the programme will provide 30,000 teachers with: the choice of 200 courses at higher education level in both subject theory and educational pedagogy; the opportunity to choose regular courses provided by universities; the exchange of views and experience with other practising teachers; opportunities to study using distance technologies; and courses available in various part time modes or full time. The competence development training programme for teachers has been evaluated and the report<sup>94</sup> is available in Swedish.

Sweden also has an initiative, *Matematiksatsningen*<sup>95</sup>, which consists of a government grant available to state and independent school principals to invest in development projects and training to enhance the quality of mathematics teaching at compulsory school level, during the period 2009-2011. The national evaluation of compulsory school NU-03 showed that mathematics teaching is not excelling as teaching and discussion has been reduced and individual work has increased. The study also indicated the need for teaching time to be used in a more constructive way in order for students to develop their maths skills more effectively. Moreover, the analysis of the results of the TIMSS international assessment in 2007 shows that many Swedish students make systematic errors in calculation procedures that need early detection and processing. The aim of the government grant, together with the provision of teaching support materials from the *National Centre for Mathematics Education* at Göteborg University, is to stimulate and strengthen the schools' own development efforts to enhance the quality of mathematics teaching. Many of the development projects use modern technical tools such as interactive whiteboards and laptops in their attempt to improve teaching effectiveness. The initiative will be evaluated by several universities in terms of its success in increasing the number of students leaving school with at least a passing grade in mathematics.

Sweden also has a specific policy measure entitled NTA - *Naturvetenskap och Teknik för Alla* (Science and Technology for All)<sup>96</sup> which is a school development programme run jointly by the Royal Swedish Academy of Sciences and the Royal Swedish Academy of Engineering Sciences in cooperation with municipalities throughout Sweden. In the participating municipalities, NTA provides support for local development of the curriculum in primary level science and technology. The programme is currently primarily aimed at classes from kindergarten through to 7th grade (children aged 13 years old) but will be expanded to cover all grades of compulsory school. NTA aims to stimulate interest in science and technology, to enhance scientific literacy, and to encourage more young people to choose an education which leads to careers in science or technology. NTA started in 1997 and has been financed by the Ministry of Education and Science and by different private funds. This Swedish measure is again based on evidence from international reports such as the Rocard report, which emphasises the need to develop science and technology education in the early years of schooling. Swedish primary school teachers, like in many other countries, are not necessarily specialists in science and technology, having various other disciplinary backgrounds. This measure

therefore particularly targets these teachers needing support in providing interesting and effective lessons in these fields. The overall aim of the initiative is to provide the government with a knowledge base for deciding a future position on investments in science and technology in early year's education.

## 4.3 Updating teachers' ICT skills

Curricular reform has instigated new developments in ICT teacher training in **Turkey**. Initial teacher training institutions have adapted their training programmes according to the new Turkish science curriculum, and in-service teacher-training has been provided by the Ministry of Education to help teachers integrate new ICT-based science laboratories<sup>97</sup> and the education portal into science teaching. Moreover, the *Fatih Education Project*<sup>98</sup> (2011-2016) supports schools' and teachers' ICT development through five actions: provision of hardware and software infrastructure; educational provision and management of e-content; instructional programmes on the effective use of IT, in-service training of teachers, and the promotion of conscious, secure, manageable, and measurable IT usage. Under the leadership of the General Directorate for Educational Technologies, the Fatih project is also engaging in studies and pilot projects related to teaching and learning with the aid of e-books and e-lessons. The project is being implemented by the Ministry of National Education, and supported by the Ministry of Transport. The project's overall goal is to contribute to Turkey's so-called 'e-Transformation'.

Also as a result of ongoing curricular reform, the **Slovak Republic** has marked ICT competence as a key competence for all pupils since 2008. To make this a reality, there is a need to ensure that ICT teaching is up to standard. To meet this need the Ministry of Education in cooperation with 5 faculties of different higher education institutions has implemented the *DVUI national training for 1500 informatics teachers* from the period 2008-2011, involving each teacher receiving a notebook for learning purposes. This programme has now come to an end but is being followed up by the MVP training initiative (2008-2013) which has enlarged its scope to teachers coming from a large breadth of subjects at lower and upper secondary level, including all STEM subjects. As in the previous training programme, each teacher involved in the MVP training initiative receives a notebook, and is trained to integrate the use of ICT into their subject teaching effectively.

**Portugal** has a similar national initiative, whereby school teachers at all levels are offered the possibility of buying laptops at special prices in order to promote their confidence and use of ICT-based tools in their teaching<sup>99</sup>.

To start monitoring students' progress in the **Slovak** initiative, the National Inspectorate of Education has carried out an initial ICT focused inspection in sample schools at all education levels, throughout the country in 2008-2009. Inspectors monitored different indicators, including key competences, one of which being students' digital competence. Evaluation reports have been made on the basis of the school observations and on the questionnaire responses of head teachers and teachers, and future policy making in this area will be based on this evidence.

Another initiative the Slovak Republic is involved in, related to updating teachers' ICT skills, is the Microsoft *Partners in Learning*<sup>100</sup> programme. It is a global initiative with more than 85 field-based staff, covering 114 countries. The programme is dedicated to enabling access to technology, supporting leadership and the use of ICT in teaching, and building a sense of community in all participating schools. It aims to develop new approaches to teaching through the professional development of teachers, by providing them with tools for collaboration, and the sharing of knowledge and experience within the region and around the world. The initiative has so far trained over 8.8 million teachers and school leaders, and has reached 198 million students. The Slovak Ministry of Education firstly got involved in the programme in 2004, and renewed its membership for the period 2008 to 2013. Concretely, the programme<sup>101</sup> is implemented through three main actions: Innovative teachers (providing teachers with tools, forums and resources to build communities of practice, support collaboration and access to high quality content, and support

teachers in integrating ICT into teaching and learning in a meaningful way. Peer learning among teachers is organized in 50 clubs, and regular events include an annual conference, roadshows and competitions for teachers); Innovative schools (providing schools, governments and partners with resources, training, expertise and technology blueprints that help schools to better prepare students for life and work in the 21st century. There are several schools involved in testing in a 1:1 computing pilot project<sup>102</sup>, and 8 of these schools are supported by Microsoft); Innovative students (empowering secondary level students to use ICT in their schoolwork and learning. Students are informed about cyber security on the internet, and the effective and safe use of social networks either through face-to-face discussions in certain schools or by resources provided on a dedicated website<sup>103</sup>). With the help of its partners and based on their needs and priorities, including those of the Slovak Ministry of Education, the Partners in Learning programme will continue to invest in relevant areas of research, including the benefits of teaching using ICT, and the impact on teachers' methods and the curriculum.

Over the period 2008-2011, **Lithuania** has been implementing a technological competence training programme<sup>104</sup> for vocational teachers and college professors to enable them to teach company employees from various sectors (including engineering) in newly established sectoral practical training centres, to work with up-to-date technologies. The aim is to carry out 100 technological competence training programmes for 650 practitioners (580 vocational teachers of upper secondary school students and 70 college professors) in association with 12 industry sectors by the end of the project. The project is mostly funded by the European Social Fund, and is being implemented by the Lithuanian Ministry of Education and Science. The average duration of the training received by the practitioners is 3 months. At the end of the training each participant's technological competence will be assessed in accordance with the requirements set out in the Action Plan, and on successful compliance, a certificate of skills acquisition and development will be conferred. The project aims to provide an effective model for improving technological competences among vocational teachers and college professors in the first instance, and as a result among students and employees as well.

The **Czech Republic** also has two forthcoming projects in the professional development area, but related to all teachers, and not just vocational ones. The *Support for technical and natural sciences education* project (2012-2013) targets the development of teachers' ICT skills, supporting them via digital materials and text books, and providing them with additional training through e-learning courses. The use of social networks in the development of this project is also envisaged, to strengthen its participatory and community nature. A second programme aimed at the *Professional support of teachers* (2012-2013), will provide teachers with methodological materials and relevant e-learning courses. Moreover, the Faculty of Mathematics and Physics, at the Charles University in Prague runs summer schools<sup>105</sup> for ICT teachers teaching at secondary schools.

**Romania** has a national strategy running from 2010-2013 dedicated to training teachers to create their own educational software<sup>106</sup>. The strategy is an initiative of the Ministry of Education, Research, Youth and Sports, and is being carried out in partnership with the software company SIVCO Romania SA. Teachers of all STEM subjects at primary and secondary level are targeted by the initiative.



## Guiding students towards STEM careers

The transition from school life to working life is an important aspect of several of the initiatives mentioned by various countries. In order to encourage students to choose STEM careers, they need a better idea of what working in the STEM professions is actually like. Countries have taken different approaches to meet this need. One approach is to invite STEM professionals or university students into schools to work with teachers and students, while another is to allow teachers and students to visit STEM work places.

In **Norway**, a pilot programme entitled Teacher II – a support from working life is currently taking place (2009-2010), involving representatives from industry coming into 40 schools and teaching alongside the ordinary teachers in special parts of the STEM curriculum. This initiative has the goal of making teaching more up to date and relevant to the current STEM world of work. It also allows students to see how STEM subjects are used in industry, and brings a taste of working life into the classroom.

In a much wider programme with a similar aim, **Israel's** TaasiYeda (Industry Knowledge) initiative has been implemented in the school year 2010/2011 in partnership between the Ministry of Education's Administration for Science and Technology and the educational branch of the Manufacturer's Association of Israel, Tassiyeda. The initiative's goal is to increase students' and teachers' acquaintance with the actual activities of the industry in Israel, through a variety of means. These include partnerships between schools and industry, specific workshops and programmes on the application of STEM learning to everyday work in industry, as well as competitions and practical study visits to industrial plants. This large cooperation programme also aims to bring managerial know-how from the industrial sector to support school principals through its special sub-programme, Manager adopts a Principal, whereby a dialogue between industry managers and school directors is established. The purpose is to help the educational system to generally progress successfully and in particular in the disciplines of science and technology. The application of technologies and advanced management methods from industry will concretely be implemented through 80 pairings of managers and principals together with 12 workshop meetings and lectures, alongside interpersonal dialogue.

Like Israel, the **Netherlands** also has two projects involving partnerships between schools and industry, specifically targeted at providing students with a practical insight into potential careers in the technological sector. The *Jet-Net*<sup>07</sup> project accomplishes this at general secondary school level, while the *Tech-Net* project focuses on vocational education and training. *Jet-Net*, Youth and Technology Network Netherlands, is a joint initiative of leading Dutch technology companies and secondary schools. Together they provide students with experiences that show that technology is challenging, meaningful and socially relevant. In collaboration with the schools, the companies develop an educational environment with practical content for the science curriculum. Through guest lessons, workshops and many other activities, young people see with their own eyes that varied and interesting jobs in technology do exist. The *Jet-Net* project was founded in 2002 by Unilever, Shell, AkzoNobel, DSM and Philips, with the aim of increasing the interest of general secondary school students in science and technology. There are 70 companies nationwide that participate in Jet-Net (often with multiple locations). 170 schools (a third of all schools in general secondary schools and pre-university education in the Netherlands) participate. Among schools the enthusiasm to join is so strong, that there is a regional waiting list of 100 schools. Each year 300 science teachers and student counsellors take part in the national Teachers' Day, and in 2010, 3,500 students from general secondary and pre-university education attended Jet-Net's Career Day. The Tech-Net project works in a very similar way, and involves partnerships between roughly 1,900 companies and 277 vocational schools.

The abovementioned Dutch project's promotion of one to one collaboration, whereby one company is paired to one school via direct communication, is a principle also shared by the **Czech Republic's** *Science is the Future*<sup>108</sup> project. The aim of the project is to increase the attractiveness of science and technology for elementary and secondary school pupils through a cooperation of companies and schools, demonstrating to young people that a career in this field has a future. The project is a part of the platform Schools Business - Business schools, which is based on the successful initiative of the Irish School of Business Partnership, currently involving 120 large companies and 167 secondary schools throughout Ireland. The Czech version of this project is in its initial stages and currently involves two companies, Bayer and IBM, and two pilot schools. The project is aimed at primary schools (8th grade) and secondary schools (3rd grade), and consists of four modules: working skills (excursions, CV workshops and science in practice sessions), mentoring; part-time jobs for pupils; and teacher training. The project is coordinated in partnership between the civic association AISIS, representatives of the Ministry of Education and the corporate sector, as well as the project managers of the original Irish project. On a more local level, like in the Netherlands, the Czech Republic has partnerships between vocational secondary schools and local businesses in their immediate neighbourhood or region. Excursions and work placements are common activities for these partnerships, and some active schools also apply (through their local authority) for projects financed by EU structural funds to support school trips to local businesses. Moreover, on 13 September 2011, the Czech Ministry of Education chose STEM education as the topic of its annual international conference. The conference was entitled *Partnership for Maths Science and Technology: support for the teaching of mathematics, natural sciences and engineering through cooperation between schools and businesses*<sup>109</sup>.

In **Estonia**, the focus is more on bringing STEM professionals and industry into the classroom. Since 2007 there has been a national initiative called Science Bus tours to Schools involving groups of university students organizing science activities and discussions in schools for students. The initiative's main goal is to increase students' interest in and awareness of the possibilities to study STEM subjects at university level and beyond. So far over 300 schools have been involved and responses from students have been positive. There is a high demand for other schools to take part in the initiative. Similarly, the Estonian ICT Roadshow was a campaign involving university students encouraging school pupils to take up ICT studies and careers in 2006-2008, organized together with the private Association of Information Technology and Telecommunications. Additionally, the Õpikodade Programm<sup>110</sup> (Science Workshops Programme) is the most recent national initiative implemented in Estonia in 2010 to encourage upper secondary school students aged between 17 and 19 years old to continue further studies and careers in the STEM field. Teams of science specialists and professionals organize monthly special science activities and courses in regional centres located in schools across the country. The workshops are open to every student, and the initiative is being run by the Ministry of Science and Education in cooperation with the Estonian Physics Society of the University of Tartu. Currently 1,400 students are participating in this Estonian programme, and the preliminary responses from students and teachers alike are very positive. This has resulted in a high demand for students to attend from schools especially where there is a lack of qualified STEM teachers.

**Slovenia** have a similar promotional campaign launched in 2011, and organized by universities at regional level, whereby faculty representatives will visit schools to motivate the study of physical sciences at upper secondary level, to eventually increase the number of students choosing to study this area at university.

In **Finland** rather than organizing for STEM higher education students or professionals to come into the school, there are programmes in place allowing teachers and students to visit industrial organizations to increase their knowledge of STEM professions.

**Switzerland's** SimplyScience web portal (<http://www.simplyscience.ch>) includes a career guidance platform targeting students aged 12-16, and covering all STEM areas. In future the platform will also cater for age groups below 12 and above 16, vocational education, teachers, and career consultants. Boosting young learners' dwindling interest in STEM subjects is the main objective of Simply Science. The platform will be expanded in future to include



technology and engineering sciences. The SimplyScience web portal was initiated by SGCI Chemie Pharma Schweiz, the Swiss association of chemical and pharmaceutical companies.

**Portugal and Belgium (Flanders) have targeted specific STEM areas in their career guidance initiatives, in order to respond to local professional needs or shortages.**

A more focused approach in encouraging students more particularly to take up careers in biomedical research and related areas can be seen in **Portugal's** *Champimóvel*<sup>111</sup> project. In 2008 for the first time Portuguese youngsters aged between 9 and 14 years experienced an interactive tour of the human body. The Champalimaud Foundation's "Champimóvel" is a 3-dimensional, interactive and transportable simulator which continues to bring the world's most cutting-edge medical science into the hearts and minds of young students. "Champi" guides the viewer through this interactive ride of the body allowing students to witness many of the most relevant and contemporary issues in medical science such as stem cells, nanotechnology, DNA and gene therapy. These issues in biotechnology and their applicability to the improvement of the quality of life are very pertinent to the STEM objectives listed in the Portuguese basic and secondary education curricula. The Champalimaud Foundation, in cooperation with the Ministry of Education, is developing an educational programme with pedagogical materials to support the simulation learning experience, and motivate and sustain young peoples' curiosity in science, and particularly biomedical science careers.

The **Belgian (Flemish)** *De wereld aan je voeten*<sup>112</sup> (The world at your feet) project is aimed at stimulating 16-18 year old students to choose scientific or technical studies at university level, with a particular focus on encouraging students (especially female) to pursue careers as civil engineers. There are a lack of qualified engineers in Flanders, and this is in part caused by students' unawareness of the job's content, which this project tries to address by engaging students in web-quests and putting them in direct contact with professional engineers. A variety of partners are involved in the project, including both the Ministry of Science and Economics and the Ministry of Education, private companies, KVIV - the Royal Flemish Society of Engineers, and Flanders' educational portal for teachers – KlasCement. During the period 2008-2011, 192 contacts between schools and companies were made, and 402 seminars took place. The project has now been extended for a further year (2011-2012).





# Increasing the participation of women in STEM careers

**In their attempt to increase the participation of women in STEM careers, some countries have opted for workshops or summer schools for primary and secondary level female students, a role model approach whereby female STEM teachers are matched to female students, or testimonial websites where STEM professionals share their career paths with students.**

**Swedish** school boards since 1985 and for the last year in 2010 have been providing grants for Teknik för Flickor<sup>113</sup> (Technology for Girls) summer schools. School principals from both municipal and independent schools can use this funding to send female students of compulsory school age (between 6 and 16 years old) to a summer school lasting a minimum of one week and involving at least 5 students. The purpose of these technology summer schools is to encourage girls' interest in studying and pursuing a career in the natural sciences and technology fields, to strengthen their confidence in working in these areas, and to ensure that their involvement in STEM can benefit them as individuals as well as society and the environment as a whole.

The Faculty of Information Technology, at the **Czech** Brno University of Technology also holds a special annual IT summer school for girls<sup>114</sup>.

In September 2009, the **Swiss** foundation *Swiss Science and Youth*, in cooperation with the University of Basel, also offered a workshop for girls aged 10-13 on various STEM topics, with a view to raising awareness of gender roles in this area, and increasing interest. On the 12<sup>th</sup> of November of each year, school girls in Switzerland have the possibility of accompanying one of their parents to work, in the 'take-your-daughter-to-work day'<sup>115</sup> annual project, which has been very successful over the last nine years. As part of this project they can also take part in a national programme which introduces them to professions in the technical sector and computer sciences, usually mostly filled by men. More than 10,000 girls have taken part in the project so far<sup>116</sup>.

The Emancipation Department of the **Dutch** Ministry of Education and Culture has launched a policy measure involving the development of special projects to get girls interested in STEM. The Netherlands are also beginning to try a role model approach, whereby female STEM teachers are matched to female students to inspire them to take up STEM careers. Another Dutch initiative using a testimonial approach is a website where mathematics teachers provide information about their own personal paths leading to their careers in mathematics<sup>117</sup>.

**France** has a similar website, *Elles en Sciences*, dedicated to the testimonials of women working in the STEM sector, targeted at secondary and university level students, their parents and teachers.

The **Slovak Republic** also provides the educational community with a portal<sup>118</sup> aimed at popularizing science and technology in society, with an area dedicated to women in science.

**Norway, Austria and France have national policies to ensure gender equality across their education and training systems.**

**Norway** has an Action Plan for Gender Equality across the education and training system, and a part of this action is focused on increasing the number of girls choosing to study STEM subjects.

**Austria** has an acute gender imbalance with regards students who choose to pursue STEM studies, and the girls who do consistently perform worse than the boys, as evidenced by the international PISA tests. For this reason, the IMST project (described in section 2.3 of this report) established a *Gender Network*<sup>119</sup> aimed at mainstreaming gender equality and creating a culture of gender sensitivity within the educational community. The network is responsible for ensuring these gender principles are maintained throughout the IMST's project activities. The network's goals are to reduce potential resistance to gender issues, raise teachers' awareness of gender issues through training, advice and information, and encourage teachers to look beyond gender by recognizing the individual talents, interests and needs of students. Among the concrete objectives of the network's work plan for the period 2010-2012 are: advising teachers on gender-related issues, mediating the work of gender experts, developing a handbook for teachers on gender-equitable science education, ensuring the inclusion of gender sensitive language in the evaluation reports of all initiatives taking place under the IMST project, and providing continuous professional development on gender-related issues. The network also produces a quarterly gender newsletter which provides information on events, new publications, trends and research topics in the field of gender and diversity. Two examples of recent publications produced by the gender network include a comparative study on gender issues in physics education at secondary level in Austria and Ireland<sup>120</sup>, and two reports containing information and suggestions for the implementation of gender equality in elementary<sup>121</sup> and secondary<sup>122</sup> schools.

Gender issues related to STEM is also high on the agenda in **France** where an inter-ministerial covenant has been set up for the period between 2006 and 2011 to promote equal opportunities between girls and boys in the education system. The covenant states that the proportion of girls choosing to follow the scientific and technological strands of study in the final years of secondary education should be increased by 20% by 2010. Additionally, France has various competitions and financial prizes to encourage women to enter the STEM professions. For example, the national competition *Conjugez les métiers du bâtiment au féminin!* organized by CAPEB<sup>123</sup>, with the support of the ministries in charge of equality and education, is open to students aged 15-16 who are required to design projects on the theme of women in the construction professions. *Le prix de la vocation scientifique et technique des filles (PVST)* is an example of an annual grant of €1,000 awarded to 650 students in their last year of secondary education who decide to go on to study STEM subjects at higher education level, in areas with very few female students.

## 7.1 Overarching technology strategies

**Austria's *efit21 - Digital Agenda for Education, Arts and Culture***<sup>124</sup> was launched in 2010 and sets specific priorities for the integration and use of new information and communication technologies in Austria's educational, artistic and cultural institutions. Its objectives are: to enhance the quality of teaching and learning through the effective use of ICT; equip all students with the necessary digital competences for personal, professional, social and cultural well-being; provide ICT training in schools to impart labour market-relevant skills to students; use ICT in educational and cultural management to improve efficiency and promote a sustainable organizational model; remove barriers to the access of ICT for all to improve overall social participation and integration, with a focus on media literacy and e-safety; and use ICT to make Austria's artistic and cultural heritage accessible to all. Many educational initiatives exist under the *efit21* digital agenda's umbrella, such as the *eLearning Cluster*<sup>25</sup> representing an Austria-wide network of currently around 170 secondary schools, as well as more specifically STEM-related activities, including the promotion of the European Union's Open Science Resources portal, allowing access to a digital data collection of scientific institutions and museums in Europe.

The Excellence in Education priority line is governed by the Technological Plan for Education, approved by the Council of Ministers in 2007. Its main goal is to consolidate Portugal's position as a benchmark in the availability and use

of ICT tools for the improvement of the teaching and learning process. There are 6 measures within the education action line of the digital agenda, including one specifically related to the mathematics aspect of STEM education. These are: personal website areas for students, teachers and parents; virtual learning platforms; virtual workbooks; Portuguese language cyber-school; online school enrolment and certification; and a virtual mathematics tutor. The virtual system for learning mathematics targeted at primary school grades 1 to 4, strives to: help students in learning mathematics through virtual tutoring sessions; help teachers in teaching mathematics through learning tools that can be used with computers and/or interactive whiteboards, as well as digital tools allowing teachers to create their own content; support parents and guardians, enabling them to follow their children's progress in learning mathematics; and provide technical support to students, teachers and guardians regarding technical queries on the use of the virtual tutor. During 2010-2011 the virtual mathematics tutor completed a successful pilot phase, and its implementation will be extended until 2015. The potential expansion into other disciplines, both STEM and non-STEM related, is being considered.

## 7.2 The use of ICT in STEM teaching

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**More than half of the countries surveyed state they only have general statutory documents detailing how ICT should be used throughout the school curriculum, whereas in Finland, Norway, Sweden, Belgium (Flanders), France, Denmark, Spain and Portugal, specific guidelines are given for its use in STEM teaching and learning.**

ICT is generally valued by all countries for its ability to diversify the learning process and make the studying of STEM subjects more entertaining and attractive. Several reasons are given for the added value of using ICT for teaching STEM. These include: collecting, recording and analyzing data; allowing the possibility to carry out safe and quick experiments otherwise not possible in the classroom due to lack of equipment or risk of danger; simulation and visualization of 3D structures in science; and modelling in mathematics. Countries also mention the more general learning benefits associated with ICT, also applicable to STEM subjects, including: the ability to display information in clear, presentable and different formats (such as graphs and pie charts); access to the internet and multimedia digital content; sharing information online through collaborative and interactive web environments; allowing more active and self-regulated/personalized learning without time or place restrictions; and allowing students to practise repeatedly and obtain results speedily. Incorporating ICT into STEM teaching and learning is also highly rated for providing students with the latest e-skills and opportunities for international networking, needed for effective participation in today's globalized world.

In **Estonia** and **Finland** the use of technology is a cross-curricular theme, which has to be respected in the teaching of all subjects, including STEM. In **Portugal**, general learning outcomes in the area of ICT are also specified, and similar to Estonia and Finland, are based on a trans-disciplinary principle. In **Ireland** the integration of ICT in the teaching of all subjects is guaranteed by its National ICT Framework where the use of ICT is stipulated as a pedagogical method to be used throughout the curriculum. In **Norway** it is defined as a basic skill to be used throughout schooling, as is the case also in **France**, where the fourth skill of the Socle Commun de Connaissances et de Compétences (Common Base of Knowledge and Skills) is devoted to the use of ICT. In the **Czech Republic** however, there are no statutory documents specifying how ICT should be used in teaching and learning – schools have autonomy in deciding this. Unlike the **Netherlands** however, (which is an exception in having no official ICT objectives or recommendations of any kind at national level<sup>128</sup>, the Czech Republic's statutory documents do contain some general recommendations for the use of ICT in teaching and learning. More than half of all countries surveyed state that there are general statutory documents detailing how ICT should be used for teaching and learning throughout schooling, but no specific guidelines for the use of ICT in STEM subjects.

Countries where specific guidelines do exist on how to use ICT for STEM teaching and learning in particular include: **Finland**, where guidelines to this purpose are given in the national core curriculum; **Norway**, where the use of ICT is detailed in the competence aims of each subject at every level in the new Knowledge Promotion curriculum; **Sweden**, where similarly subject specific ICT competences are integrated into each subject in the new curricula for compulsory education (7-15 year-olds) and upper secondary school education (16-19 year-olds) to be enforced in the autumn term of 2011; **Belgium (Flanders)** and **France**, where the use of ICT is specified in the official programme of each subject; and **Denmark, Spain** and **Portugal**<sup>129</sup> where how ICT should be used is outlined in the methodological recommendations of the syllabus for each STEM subject.

**ICT is used in the teaching of all STEM subjects in all countries surveyed, albeit to varying extents.**

In the **Slovak Republic**, ICT use is rare in this area, primarily due to the general lack of computers in schools.

In **Austria**, although the use of ICT is mandatory in the teaching of all school subjects, the law regulating the grading of students does not stipulate the use of ICT, which leads to teachers often not actually using it in practice.

**Estonia** also claims that while a considerable amount of teachers do use ICT in the teaching of STEM subjects, many do not mainly because this would require changing traditional teaching habits and a willingness to leave their comfort zone.

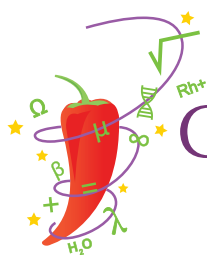
Interestingly in **Finland**, ICT is in fact used significantly more in other subjects (as illustrated by the results of SITES 2006), and STEM teachers are said to be very critical about the use of ICT and educational software. This seems to be in direct contrast with Italy, where there is evidence that many STEM teachers produce digital learning objects which are collected on the national education portal for the training of teachers, *PuntoEdu*, and made available to all teachers.

This comparative overview of the various national initiatives, policy actions and reforms taking place in 21 European Schoolnet member countries demonstrates that increasing students' interest in pursuing STEM studies and careers is still very much an issue of importance for Ministries of Education across Europe. The report highlights that these countries are facing the same challenges and are often opting for similar solutions.

National and regional actions identified in the report include curricular reform favouring inquiry based learning, the establishment of networks of teachers and other stakeholders, teacher training, campaigns and competitions targeting students, as well as initiatives encouraging the uptake of STEM careers and the participation of women. The long term goal of these different measures is to develop a sustainable scientific culture, deep rooted in society, to ensure Europe's contribution to and benefit from a bright future of scientific and technological innovation.

The majority of the national initiatives and reforms identified in this report have only been in place for a limited period of time, and therefore no evaluation is yet available, although sometimes planned. It would be of great value for countries that have not yet planned evaluations of the various initiatives and reforms in place to do so, and those that have to make the results public when available. This 2011 report interestingly shows that since certain STEM strategies and initiatives were reported on in the previous 2010 report, they have either been extended or new ones have replaced them. Either way, despite government budget cuts, Ministries of Education as well as the private sector are still investing in strengthening the quality of STEM education, in the belief that doing so will inject the growth and innovation Europe so very much needs. We look forward to integrating further national information into a regularly updated version of this report in the future. Potential synergies with the work of the European Commission's MST cluster are also to be considered within the framework of European Schoolnet's follow-up of developments in the STEM field.





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## Endnotes

- 1 Eurydice (2011) Science Education in Europe: National Policies, Practices and Research
- 2 Eurydice (2011) Mathematics Education in Europe: Common Challenges and National Policies
- 3 Eurydice (2006) Science Teaching in Schools in Europe, Policies and Research
- 4 Osborne J. and Dillon J. (2008) Science Education in Europe: Critical Reflections:  
[http://www.nuffieldfoundation.org/fileLibrary/pdf/Sci\\_Ed\\_in\\_Europe\\_Report\\_Final.pdf](http://www.nuffieldfoundation.org/fileLibrary/pdf/Sci_Ed_in_Europe_Report_Final.pdf)
- 5 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](http://ec.europa.eu/research/science-society/document_library/pdf_06/report-rocard-on-science-education_en.pdf)
- 6 The Spice project is a European Commission funded project, under the Lifelong Learning programme, which aims to collect, analyse, validate and share innovative pedagogical practice, particularly focused on inquiry-based learning, whilst enhancing pupils' interest in the sciences. The SPICE project will single out best practice teaching approaches in maths, science and technology, and share them throughout Europe. The best practice criteria will provide guidelines to guarantee the quality and innovative nature of new projects. The Spice project is coordinated by European Schoolnet (EUN) in partnership with Direcção Geral de Inovação e Desenvolvimento (DGIDC) from Portugal and Dum zahraničních služeb MSM (DZS) from the Czech Republic. See <http://spice.eun.org>.
- 7 Austria, Belgium (Flanders), the Czech Republic, Denmark, Estonia, Finland, France, Ireland, Israel, Italy, Lithuania, the Netherlands, Norway, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, and Turkey.
- 8 The Rocard report recommends the development of teachers' networks as being valuable for improving the quality of teaching and stimulating motivation.
- 9 <http://spice.eun.org>
- 10 Kearney, C. (2010) Efforts to Increase Students' Interest in Pursuing Mathematics, Science and Technology Studies and Careers: National Measures taken by 16 of European Schoolnet Member Countries, European Schoolnet, Brussels.
- 11 Where footnotes providing references to websites or online/offline reports are given with no language indication, the information is available in English. When the information is not available in English the language it is available in is indicated.
- 12 <http://www.ksll.net/PeerLearningClusters/clusterDetails.cfm?id=12>
- 13 For example, see: McKinsey & Company (2007), How the World's Best-performing School Systems Come Out on Top, [http://www.mckinsey.com/client-service/socialsector/resources/pdf/Worlds\\_School\\_Systems\\_Final.pdf](http://www.mckinsey.com/client-service/socialsector/resources/pdf/Worlds_School_Systems_Final.pdf), and Hattie, J. (2003, October), Teachers Make a Difference: What is the Research Evidence? Paper presented at the Australian Council for Educational Research Annual Conference on Building Teacher Quality, Melbourne
- 14 In other words, it seems logical that the better the quality of MST teaching, the more attractive careers in this area will be to learners, just as the more MST teaching focuses on socio-economic issues of interest to girls, the more likely the gender balance issue in MST studies and careers will be resolved.
- 15 Of course other factors, including making employment opportunities in the MST market more attractive for young people, are also part of this drive.
- 16 Netherlands, Norway, Ireland, Israel, Switzerland, Italy, Finland, Denmark, the Czech Republic, Portugal and Spain
- 17 <http://www.manifestwt.nl/images/manifest/MasterplanPOdef.pdf> (Full text in Dutch with a management summary at the end of the document in English)
- 18 <http://www.manifestwt.nl/images/manifest/Manifest-EN.pdf>
- 19 [www.schoolaanzet.nl](http://www.schoolaanzet.nl)
- 20 <http://www.centresofexpertise.nl/> (in Dutch)

- 21 <http://www.centresofexpertise.nl/docs/Beleidsdocumenten/planciehermans.pdf> (in Dutch)
- 22 <http://www.centresofexpertise.nl/docs/Beleidsdocumenten/planciedeboer.pdf> (in Dutch)
- 23 <http://www.wetenschapmaaktknep.be/&usg=ALkJrhg8U2VJ44pmqZETCTMCpzzw5wj1HQ> (in Dutch)
- 24 <http://www.wetenschapsinformatienetwerk.be/>
- 25 <http://technopolis.be/eng> (in Dutch)
- 26 <http://www.regjeringen.no/upload/KD/Vedlegg/Strategi-%20Realfag%20for%20framtida.pdf> (in Norwegian)
- 27 Discover Primary Science Programme in section 4.2 In-service Teacher Training Programmes
- 28 <http://www.education.gouv.fr/cid54824/une-nouvelle-ambition-pour-les-sciences-et-les-technologies-a-l-ecole.html> (in French)
- 29 <http://cms.education.gov.il/EducationCMS/Units/Scitech/TchumMadaim/NoarShocherMada/> (in Hebrew)
- 30 These summer camps offer activities on science and technology which are integrated with subjects from the humanities.
- 31 The private partners involved are: ABB Schweiz AG, Cisco Systems, IBM Forschungslabors Zurich, Lonza AGs, Meyer Burger AG, and OC Oerlikon
- 32 17% of Switzerland's work force are women working in technically oriented careers – a small proportion, very low by international standards.
- 33 The first of the Working Group's actions has been an enquiry into the laboratory equipment in schools. The enquiry analyzed the situation in 11,000 schools, with a more in-depth analysis on a sample of 1,400 schools. The results were presented in May 2008 and suggest that schools need a better supply of equipment and also teacher training in order for staff to be able to use this equipment effectively. The report is available on the Ministry of Education's website at [www.istruzione.it](http://www.istruzione.it).
- 34 <http://www.helsinki.fi/luma/english/introduction/shtml>
- 35 <http://rvo-society.be>
- 36 <http://www.skolverket.se/sb/d/3631/a/12119> (in Swedish)
- 37 <http://www.fi.uu.nl/en/welcome.html>
- 38 Mathematics, physics, chemistry, computer science and technology
- 39 Mainly targeted at students aged 7-18
- 40 <http://www.iqpark.cz/en/> and <http://www.techmania.cz/> (in Czech)
- 41 For example see: Talnet project (<http://www.talnet.cz>); StarTech project (<http://www.startech.cz>); and Science in the Streets project (<http://www.ceskahlava>)
- 42 <http://www.tyzdenvedy.sk/information-in-english>
- 43 [http://www.minedu.sk/data/USERDATAEN/VaT/veda\\_technika\\_ENG.pdf](http://www.minedu.sk/data/USERDATAEN/VaT/veda_technika_ENG.pdf)
- 44 <http://www.universcience.fr/en/about-us/contenu/c/1248108396090/universcience-fr-website/>
- 45 Other activities undertaken by this organization include Science Team K, a Danish regional development project highlighted by the OECD as best practice, as well as international collaboration projects in association with the European Science Events Association (EUSCEA), of which it is co-founder.
- 46 [www.scienceweek.ie](http://www.scienceweek.ie)
- 47 [www.mathsweek.ie](http://www.mathsweek.ie)
- 48 [www.engineersweek.ie](http://www.engineersweek.ie)
- 49 [www.scifest.ie](http://www.scifest.ie)
- 50 <http://www.course-en-cours.com/> (in French)

- 51 [www.cangurul.ro](http://www.cangurul.ro) (in Romanian)
- 52 <http://rms.unibuc.ro> (Romanian and other languages)
- 53 [www.oi.sk](http://www.oi.sk)
- 54 [www.p-mat.sk](http://www.p-mat.sk) and [www.pikomat.sk](http://www.pikomat.sk)
- 55 [www.pikofyz.sk](http://www.pikofyz.sk)
- 56 [www.ksp.sk](http://www.ksp.sk)
- 57 [www.seminardelfin.sk](http://www.seminardelfin.sk) and [www.p-mat.sk](http://www.p-mat.sk)
- 58 <http://ibobor.sk/> (in Slovak) and <http://www.bebas.org/en/welcome> (in English)
- 59 The International Olympiad on Computer Science; The Asian Olympiad and the International Olympiad on Physics; The International Olympiad on Mathematics; The International Competition for Young Scientists
- 60 Competition Olympi Da (Olympiad Knows); Competition on Biology; The Shalhevet Fraier Physics Competition; The Olympiad on Astronomy and Space; The Mathematics Competition by mail
- 61 <http://www.regjeringen.no/upload/KD/Vedlegg/Strategi-%20Realfag%20for%20framtida.pdf> (in Norwegian)
- 62 [www.skolverket.se/matematik](http://www.skolverket.se/matematik) (in Swedish)
- 63 <http://cms.education.gov.il/EducationCMS/Units/Scitech/EshkolotPays/MateHaHala/TafikidHamate.htm> (in Hebrew)
- 64 <http://imst.uni-klu.ac.at/> (in German, including a short project description in English)
- 65 [www.pedagogika.lt](http://www.pedagogika.lt)
- 66 [www.pedagogika.lt](http://www.pedagogika.lt)
- 67 <http://galimybės.pedagogika.lt/> (in Lithuanian)
- 68 <http://transdisciplinar.pmu.ro/> (in Romanian)
- 69 [www.liceu.rocnee.eu](http://www.liceu.rocnee.eu) (in Romanian)
- 70 [www.cadru.rocnee.eu](http://www.cadru.rocnee.eu) (in Romanian)
- 71 <http://www.tubitak.gov.tr/en/ot/10> (in English and Turkish)
- 72 <http://earged.mbe.gov.tr> (Turkish)
- 73 [www.skolverket.se/skola2011](http://www.skolverket.se/skola2011) (in Swedish)
- 74 [www.skolverket.se/gy2011](http://www.skolverket.se/gy2011) (in Swedish)
- 75 <http://www.edk.ch/dyn/12930.php> (in German)
- 76 For further information regarding the Mathematics Programme for Basic Education see p. 20-21 of Beernaert Y. (2008) Mathematics, Science and Technology Cluster. The action plan for mathematics, the action plan for science and the promotion of scientific culture in Portugal.
- 77 The Framework Education Programme for Elementary Education is available at: [http://rvp.cz/informace/wp-content/uploads/2009/09/RVP\\_ZV\\_EN\\_final.pdf](http://rvp.cz/informace/wp-content/uploads/2009/09/RVP_ZV_EN_final.pdf)
- 78 <http://www.eupenizeskolam.cz/> (in Czech)
- 79 <http://skola21.rvp.cz/> (in Czech)
- 80 [http://www.kslll.net/Documents/PLA\\_Renovation%20in%20science%20education\\_Oct.%202007\\_final%20report.pdf](http://www.kslll.net/Documents/PLA_Renovation%20in%20science%20education_Oct.%202007_final%20report.pdf);  
<http://www.education.gouv.fr/bo/2000/23/ensel.htm>; [http://www.education.gouv.fr/bo/2008/hs3/programme\\_CE2\\_CM1\\_CM2.htm](http://www.education.gouv.fr/bo/2008/hs3/programme_CE2_CM1_CM2.htm) (in French)
- 81 It is up to each school whether to use this extra time or not.



- 82 For the initiative Vyhŕnme si rukavy (Hands on) see <http://pdfweb.truni.sk/vsr/> (in Slovak). For the initiative Krimichemia (Crimichemistry) see <http://vsemba.wordpress.com> (in Slovak).
- 83 [www.discoversensors.ie](http://www.discoversensors.ie)
- 84 [www.naturesekken.no](http://www.naturesekken.no) (in Norwegian)
- 85 For further information regarding the Mathematics Programme – Teams for Success see p. 18-20 of Beernaert Y. (2008) Mathematics, Science and Technology Cluster. The action plan for mathematics, the action plan for science and the promotion of scientific culture in Portugal.
- 86 <http://www.rvp.cz> (in Czech)
- 87 <http://advancedelearning.com/> (in Romanian)
- 88 [www.scispy.ie](http://www.scispy.ie)
- 89 [www.scienceunleashed.ie](http://www.scienceunleashed.ie)
- 90 [www.primaryscience.ie](http://www.primaryscience.ie)
- 91 A total of 512 schools received awards during the 2008/09 academic year.
- 92 For further information regarding the primary teacher education programme for experimental science teaching, see p24-27 of Beernaert Y. (2008) Mathematics, Science and Technology Cluster. The action plan for mathematics, the action plan for science and the promotion of scientific culture in Portugal.
- 93 <http://www.skolverket.se/sb/d/2725/a/17208>
- 94 [http://www.statskontoret.se/Statskontoret/Templates/NewsPage\\_\\_\\_\\_\\_4476.aspx](http://www.statskontoret.se/Statskontoret/Templates/NewsPage_____4476.aspx) (in Swedish)
- 95 [www.skolverket.se/matematik](http://www.skolverket.se/matematik) (in Swedish)
- 96 <http://www.nta.kva.se/index.php?categoryid=39>
- 97 <http://fenlab.meb.gov.tr> (in Turkish)
- 98 <http://fatihprojesi.meb.gov.tr/tr/index.php> (in Turkish)
- 99 This initiative accompanies the Laptops for Students initiative, and the two go hand in hand. See <http://www.eescola.pt> (in Portuguese)
- 100 <http://www.microsoft.com/education/www/leadership/partnerships/pil/> (in English and other languages)
- 101 [www.microsoft.com/slovakia/education/pil](http://www.microsoft.com/slovakia/education/pil) (in Slovak)
- 102 [www.notebookprekazdehoziaka.sk](http://www.notebookprekazdehoziaka.sk) (in Slovak)
- 103 [www.bezpecnenainternete.sk](http://www.bezpecnenainternete.sk) (in Slovak)
- 104 [www.upc.smm.lt/projektai/sistema/modelis](http://www.upc.smm.lt/projektai/sistema/modelis) (in Lithuanian)
- 105 <http://ksvi.mff.cuni.cz/skola/> (in Czech)
- 106 [www.profesorulcreator.ro](http://www.profesorulcreator.ro) (Romanian)
- 107 <http://www.jet-net.nl/> (in English and Dutch)
- 108 <http://www.vedamabudoucnost.cz/index.php/home> (in Czech)
- 109 <http://www.et2020.cz/eu-konference.php?idc=96> (in Czech)
- 110 <http://www.fyysika.ee/opikojad/> (in Estonian)
- 111 <http://www.fchampalimaud.org/education/en/champimovel2/>
- 112 <http://www.dewereldaanjevoeten.be/keuze.html> (in Dutch)
- 113 <http://www.skolverket.se/sb/d/382/a/15285> (in Swedish)

- 114 <http://www.fit.vutbr.cz/holky/en/summerschool/index.html.en> (in English)
- 115 <http://www.tochtertag.ch> (in German)
- 116 This career day is also open to boys, who have the opportunity to discuss career options that until recently have been considered to be only for women (e.g. becoming a nurse). The number of boys taking part is also on the increase.
- 117 <http://www.fi.uu.nl/perpectief/overons.html>
- 118 <https://www.vedatechnika.sk>
- 119 [https://www.imst.ac.at/texte/index/bereich\\_id:16/seite\\_id:10](https://www.imst.ac.at/texte/index/bereich_id:16/seite_id:10) (in German)
- 120 [http://lise.univie.ac.at/artikel/Stadler\\_Endbericht\\_Irland.pdf](http://lise.univie.ac.at/artikel/Stadler_Endbericht_Irland.pdf) (in English and German)
- 121 [http://www.eduhi.at/dl/UP\\_VS\\_gesamt.pdf](http://www.eduhi.at/dl/UP_VS_gesamt.pdf) (in German)
- 122 [http://www.eduhi.at/dl/UP\\_5\\_Schulstufe\\_gesamt.pdf](http://www.eduhi.at/dl/UP_5_Schulstufe_gesamt.pdf) (in German)
- 123 Confédération de l'artisanat et des petites entreprises du bâtiment (CAPEB)
- 124 <http://www.efit21.at/> (in German)
- 125 <http://www.elearningcluster.com/> (in German)
- 126 <http://www.planotecnologico.pt> (in English and Portuguese)
- 127 <http://www.agendadigital.gov.pt> (in English and Portuguese)
- 128 It is the responsibility of the school to formulate an ICT vision within its annual school plan, meaning that the way and extent to which this is done varies across schools.
- 129 For example in Portugal the methodological recommendations for the Mathematics syllabus suggest the use of graphic calculators, and geometry software such as Geogebra.
- 130 <http://www.ingenious-science.eu/>
- 131 <http://itec.eun.org/>
- 132 <http://eskills.eun.org>



<http://insight.eun.org>  
<http://spice.eun.org>



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