Project no. 511165

Permanent EuropeaN resource Centre for Informal Learning

Structuring the European Research Area

Science & Society – European Science Education Initiative

Specific Support Actions

D4: BEST PRACTICES IN CO-OPERATION BETWEEN INFORMAL AND FORMAL SCIENCE LEARNING
WP26: INTEGRATION WITH NUCLEUS

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1. Executive summary

The present deliverable focuses on identifying the best practice in the NUCLEUS and Pencil projects in comparison with other projects. In an introductory part, efforts are made to define innovation by focusing on the key recommendations mentioned in the reports of the EU working group on Maths, Science and Technology. Reference is also made to OECD studies, to the Rocard report of June 2007 and to the deliverable 28 of WP 3 of the Pencil project. Based on the finding of this deliverable that stresses eight quality and innovation criteria, the present deliverable adds two criteria taking into account elements in the other documents analysed.

Having defined what innovation is, a description is made of a variety of programmes and initiatives to promote science education. First of all a series of national programmes are analysed in a detailed way to show that those 10 characteristics or criteria of quality and innovation or present in them. The national initiatives highlighted are: the La Main à la Pâte Initiative, plus the IEST pilot programme in France. The Delta Plan for Science and technology in the Netherlands , the NAT or natural sciences programme in Norway, and the two sinus programmes in Germany, the one for the primary and the one for the secondary school. Finally an international programme – ECOschools - is also highlighted with its innovative aspects.

The newest parts of the deliverable focus on projects within NUCLEUS and Pencil and beyond those two initiatives. Clear information is given of several projects of those two cluster initiatives highlighting the criteria for quality and innovation. The examples outside of NUCLEUS and Pencil are taken from the GRID network database, another EU project funded within action 6 ‘innovation and observation’ of the Socrates programme. All those projects show that within the framework of the national programmes, the NUCLEUS and Pencil projects and the GRID projects the same quality and innovation criteria have been used even if there has been former interaction between those projects or initiatives.

Before coming to conclusions a comprehensive comparative table is made of all the project mentioned highlighting the degree to which they respond to the 10 key criteria for quality and innovation. This is done by giving them a score. This table scores that most of the project score very high on the quality and innovation criteria. However, this comparison leads to the conclusion that 5 of the 10 criteria are definitely to be found very clearly in all projects or programmes but that there is still room for improvement as to the other five criteria; even if the score they get is already good or very good.

The final part of the deliverable focuses on key recommendations in the areas where there is room for improvement. These are the following:

- Strengthen valorisation of projects and programmes at all levels as this will definitely have an impact on the cross-fertilisation and the sustainability;
- Enhance cooperation between all projects and programmes and the MST Cluster of DG EAC to enhance the impact at policy level in the different European countries involved in the Lisbon strategy;
- Promote synergy between all possible projects in innovation ; not only in science innovation but see to it that science education contributes to innovation in general;
- Focus more on the link between science education and social cohesion, inclusion and active citizenship; develop special projects and programmes for disadvantaged groups in science education;
- Highlight the way in which science education contributes to promote all the 8 key competences for lifelong learning;
- Promote the attention for action-research implemented by teachers and schools in science education to contribute to school development and to the enhancement of real learning organisation.

2. Objectives

The objective of the present deliverable is to highlight best or good practice developed in the framework of the Pencil project and other initiatives that transform informal and formal science activities into innovative quality tools for science teaching. To be able to do this reference is made first to elements of defining best or good practice and afterwards to a series of best or good practice initiatives and projects which are mentioned in other EU documents or which have been developed and described at national or regional level in different European countries. Describing the best practices can best be in done in comparing them and contrasting them with other best practice in Europe. A key element in describing best practice or good practice is of course how to define best or good practice. This is why an important part of the present contribution is spent on defining what is meant and comparing different elements of definitions to be found in different key documents and see how they concur.

Some specialists end educationalists will argue that best practice or good practice doesn't exist or that it is limited in time. They argue that 'practice' exists and that is all. Some will argue that practice is not at all transferable because it is tied to a particular context in a particular school with a specific pupil and teacher population. All of this is true but the present contribution builds on the idea that there is best or good practice that inspires and motivates other teachers to get involved in new initiatives and pedagogical practices across Europe. Experience shows that teachers in their concrete classroom are not convinced by theoretical reflections on what innovation is and how it can be brought about. Teachers (and the heads of the school, plus the parents) are interested to see which practice works. How it motivates teachers, pupils and parents and possibly other members of the educational community and the local or regional community to get involved. When they see or experience such practice teachers are attracted and motivated to try to introduce it themselves. They will take the necessary steps to take into account their particular context and situation and adapt it so as to valorise what they have been presented as an example of best or good practice.

Sometimes it may be frightening for teachers to hear 'best' practice because it may seem to them that such practice is way above their possibilities. Hence it is important also to put under best practice various initiatives: some of a simple, other of a more complex or very complex nature so as to show that best or good practice exists at different levels. In a difficult school in a disadvantaged area the best practice will probably be 'simple' activities which require very often major steps by the team of teachers. In other schools best practice can be more advanced as they have more experience in the field of promoting innovation. Hence best practice is always tied to the context. By presenting best practice in different contexts and in different situations, best or good practice becomes attainable for teachers and invites them to get involved and to try it out. The valorisation of best practice has to take into account the remarks made above which are essential to the success of valorisation, exploitation and dissemination exercises. Valorisation also best has to be done by teachers who have lived through an innovative experience and have felt themselves both the joys and sorrows of innovation attempts.

3. Methodology of defining, analysing and collecting best practice

Defining and analysing best practice is always a challenge as best or good practice should be clearly linked to innovation. To define and analyse best practice use is made for this deliverable of the work done in the framework of the same project for another deliverable viz. WP 3 D 28 Criteria of innovation and quality. This deliverable on the one hand stresses again what is meant by innovation in the Pencil project and on the other hand defines criteria of innovation plus the indicators that enable to assess whether the criteria are fulfilled.

As to innovation, reference is made to the different reports that have resulted from the working group and cluster on MST - Maths, Science, and Technology -1 set up in the framework of the Lisbon strategy 20102. Over the past six years several reports have been published and three PLA or Peer Learning activities have been organised which have also highlighted innovative practices and best practices in three European countries: The Netherlands, Sweden and France .

As to innovation, reference will also be made to key publications by the OECD: the 1999 publication "Innovating schools" and the 2003 publication "Networks for innovation"3. Finally reference is made to the ROCARD report Science Education NOW: A renewed pedagogy for the future of future"4 of June 2007. This report also highlights some examples of good practice.

Having defined "Innovation" and the criteria (plus the indicators) to be used for defining best practice, the analysis will be made of some of the examples of good practice mentioned in the Pencil project and in the GRID database 5 to see in how far they match those criteria and indicators. Materials will also be used from the reports of the previous PLA which unfortunately are not yet available on the Commission's website.

3.1 Defining Innovation

WP3 D28 of the present Pencil project mentions the following elements as to innovation:

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1 The Working Group or Cluster on, MST (Maths Science and Technology): all information see the following website: http://ec.europa.eu/education/policies/2010/objectives_en.html#math
2 The Lisbon strategy 2010: http://ec.europa.eu/education/policies/2010/objectives_en.html#math
3 Innovating schools, OECD / Networking for innovation, OECD 2003, OECD Paris
4 ROCARD report Science Education NOW: A renewed pedagogy for the future of future http://ec.europa.eu/research/science-society/document_library/pdf_06/report-rocard-on-science-education_en.pdf
5 The GRID project: a Socrates action 6 project Innovation and observation: http://www.grid-network.eu/

"From the assessment of the Pencil pilot projects, it is clear that innovation and innovative practices can be associated with a desire on the part of partners to 'do things differently, to do things better'. or example, the action of a science centre in exploring ways in which modern technologies can support early years learning, may be described as an example of 'doing something differently'. Practices such as allocating finances to ensure the sustainability of a project, meanwhile, or working in a network, employing evaluation frameworks, or developing programmes with reference to contemporary research findings, may all be considered as incidences of 'doing something better'.

With reference to future practice, it is important to ensure, however, that 'innovative practices' are not simply replicated as a way of meeting a target standard. Truly effective innovations are those that find new ways of meeting existing needs and respond to those that are currently un-met. They are also the practices that harness the energies and motivations of teachers, students and educational professionals in order to solve problems as they arise, thus continually enhancing learning and teaching opportunities."

3.2 Innovation, best and good practice in the light of Lisbon 2010

In trying to define innovation and quality in science education further as to define good or best practice, reference is made in the present deliverable to several key documents that have been produced at EU level over the past years, especially in the framework of the Lisbon 2010 strategy.

It is interesting and revealing to see that that those documents focus largely on the same innovative elements for science education.

We refer to the following documents:

- The reports of 2003 and 2004 of the WG on MST in the Lisbon strategy;
- The 2007 Rocard report 'Science Education NOW: a renewed pedagogy for the future of Europe;
- The deliverable of WP3 D28 of the Pencil project focusing on criteria for innovation and quality in science education projects;
- Two publications of OECD: Innovating schools, 1999 and Networking for Innovation, 2003;
- The reports of the MST PLA Peer Learning Activities in the Netherlands, Sweden and France of the MST cluster in 2006 and 2007.

3.2.1 Elements to be found in the EU reports of the Working Group on MST

The WG MST, maths Science and Technology has produced two major reports in 2003 and 2004 (see Annex A).

The recommendations of those two reports are particularly interesting as they also enable to distil from them criteria for innovation and quality in science education projects.

3.2.2 The characteristics of innovating schools and networking for innovation

The OECD publications "Innovating schools" (1999) and "Networking for Innovation" (2003), mention directly or indirectly the following characteristics of an innovating school:

1. Integration of innovation in mission & vision: the development of a school development plan that integrates innovation at all levels;

2. Innovative, creative , flexible learning environment focusing on key competences and LLL: learning environment promoting integration of knowledge , competences and skills across the whole curriculum;

3. Quality learning environment for ALL pupils; a learning environment that is aware of the importance of quality education and enhances self-evaluation as a key element in developing the school as a learning organisation;

4. Sustainable & Caring environment; an environment where every child can use/her his talents fully and where it feels safe, secure and respected; equal opportunities;

5. Commitment of all staff to implement innovation actively;

6. Profess. development staff, heads, teachers as a contribution to innovation;

7. Promotion of active (local, global) citizenship through all the teaching and learning

8. International and European networking as a source of innovation;

9. Links with local community / school communities / stakeholders based on partnerships;

10. School management teams with pedagogical and administrative leadership supporting innovation.

3.2.3 The Rocard report *Science education NOW: A renewed pedagogy for the future of Europe* and the Pencil Criteria for Innovation

The Pencil deliverable D28 Criteria for Innovation focused on **8 key criteria** when it comes to defining innovation (see Annex B). These criteria could also form the part of the basis to analyse the best practice described in the Pencil projects and in other projects.

The Pencil project was consulted by the experts involved in the drafting of the Rocard report *Science education NOW: A renewed pedagogy for the future of Europe* (see Annex C). Many of the findings and recommendations of the Rocard report are in way or another to be found in the deliverables of the Pencil project.

As a summary, we use the table developed by Heather King, Andres Acher and Justin Dillon King's College London and Francesco Cuomo, Marco Serpico and Emilio Balzano, University of Naples in WP3 D28 of the Pencil project, completed with two further elements or clarifications from documents mentioned above.

These characteristics focus on the degree to which the best practices developed in the framework of Pencil and GRID can be said to be innovative best practices.

However, we have added two key criteria which we think are important when it comes to good or best practice as part of a systemic innovation. Several countries have over the past years launched large systemic initiatives to enhance innovation and quality in maths, science and technology education. This is the reference for criterion 10.

Experience shows that not enough teachers reflect on what they are doing in terms of innovation. Hence the need to promote action research explicitly in the framework of innovative projects and initiatives.

Table 1: Overview of all the criteria for quality and innovation

Criteria of quality and innovation
Criterion 1: Teachers are involved in the design phase of education projects aimed at schools; professional development; reluctance to change are addressed
Criterion 2: Evaluation / assessment forms an integral part of the educational project of the whole school; assessment of theoretical work and practical work; integrated assessment of competences, knowledge and attitudes
Criterion 3: Contemporary understandings about learning and mediation are incorporated into projects; a special focus on the inquiry-based method and on integrated science teaching and learning; more effective and attractive learning methods are pursued
Criterion 4: Contemporary views about the nature and practice of science are promoted by projects
Criterion 5: Changes in competences, attitudes and motivation towards science are included in measures of efficacy alongside knowledge gain and levels of enjoyment;
Criterion 6: Project impact is enhanced as a result of reciprocal partnerships and involvement with networks or communities or authorities, parents,
Criterion 7: Initiative is sustainable
Criterion 8: Issues of social inclusion and gender equity are addressed by the project; low achieving Pupils, “second chance initiatives in science” get special attention; elements of active citizenship are also promoted
Criterion 9: Action-research based on the innovative projects separately and all those involved in a pilot programme for innovation in MST
Criterion 10:The development and implementation of a pilot programme in MST which includes needs analysis, implementation, monitoring / follow-up /support and evaluation of the projects plus the valorisation and mainstreaming in the whole education system

3.3 Examples of best or good practice of nationwide pilot programmes for Science and Technology

An important effort is made to give full and detailed information about a few of the national pilot programme that have been launched over recent years in several European countries; Special attention is given to France, Germany and the Netherlands as they are developing a fairly comprehensive national (pilot) programme or system to promote Maths, Science and Technology.

Speical attention is given to the LAMAP or La Main à la Pâte initiative and to the SINUS transfer initiatives as they are both strongly highlighted in the recent Rocard report.

Both La Main à la Pâte and the SINUS transfer initiatives have had and are having a major impact on the present development of science education in France and Germany. They also have an indirect impact on other countries through the dissemination of the information about these initiatives across Europe. La Main à la Pâte can be said to have a major impact across the world as several other countries (e.g. China) have taken on board the same inquiry-based approach to sciences.

Both the La Main à la Pâte Initiative of France and the Delta Plan Science and Technology 6 of the Netherlands have been the object of a PLA, a Peer Learning Initiative, set up by DG EAC in the framework of the CLUSTER of MST.

The Lamap (see Annex D) can be said to correspond to the 10 Pencil criteria for quality and innovation which were highlighted in the previous part of the text.

Other examples of best practice in nationwide pilot projects for science and technology that were taken into consideration:

- The PRESTE reform (see Annex E)
- EIST in France (see Annex F)
- SINUS in Germany (see Annex G)
- DELTA in the Netherlands (see Annex H)
- NTA in Sweden (see Annex I)
- CHiK in Germany (see Annex J)
- ECO Schools in Cyprus and elsewhere (see Annex K)

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6 Delta Plan Science and Technology (NL): see the website: Platform Beta Techniek: http://www.platformbetatechniek.nl/pagina_353.html

3.4 Best Practice Within and Beyond Pencil

As mentioned earlier a certain number of best practices within Pencil and outside of the Pencil project will be compared using the characteristics mentioned above.

Desktop research has been carried out based on Pencil project and on other projects (mainly from the GRID network database) to find out what are the best or good practices in the Pencil and GRID projects
The descriptions of the projects are compared to the criteria for innovation and quality mentioned earlier based on the findings and recommendations of the
Rocard report, The EU reports of the WG and cluster on MST, the Deliverables of WP 3 D 28 of the Pencil project recommendations and the characteristics of innovative schools of OECD.

3.4.1 Nucleus

Nucleus is a cluster of EU projects funded by the European Commission's Directorate General for Research, as part of the European Science Education Initiative. The cluster comprises: Pencil, ESTI, CISCI, Scienceduc and Volvox. The best practices of these projects are hereby described.

3.4.1.1 Pencil (Permanent European Resource Centre for Informal Learning)

Pencil as a whole can be said to be an example of best or good practice. The following aspects are factors in this:

- the combination of field programmes and academic research
- the mini-networks created by science centres and museums
- the new methods in science teaching.
- the academic “Resource Centre”
- the advanced communication technology used for Xplora
- the motivation study
- the final Science Teachers Network

For the purposes of this deliverable, three projects in particular are selected because they were thought to best fulfil to the quality and innovation criteria highlighted in deliverable WP3 D28:

- Heureka (Finland): “Chemistry for primary schools”
- Nemo (NL): “The School's Science Centre"
- Experimentarium (Denmark): “Xciters”

3.4.1.2 SCIENCEDUC[7]

The following elements are identified as good or best practise:

- Inquiry-based teaching methods;
- major efforts on teacher’s training, resource elaboration and educational research
- Outcomes such as the Second European conference on primary science and technology Education - Science is primary II: Engaging the new generations (Stockholm, Sweden, October 15-17, 2006). The proceedings; *National conferences for dissemination of good teaching practices:* see programs and reports of 14 conferences on science education organized during 2005; *International Summer School for science trainers*, July 2005: the proceedings; *Database and report about inquiry science teaching evaluation*, the database and report.

3.4.1.3 ESTI, EUROPEAN SCIENCE TEACHING INITIATIVE[8]

The following elements are identified as good or best practise:

- The combination of three elements: Science on Stage, Science in School and the Volvox network;
- International Science Teaching Festivals.

3.4.1.4 The VOLVOX project[9]

The following elements are identified as good or best practise:

- The provision of authoritative briefings, proven laboratory protocols, classroom activities addressing the social impact of bioscience, accounts of the careers of young scientists and numerous other educational resources to help motivate teachers and their students;

- the dynamic forum created for the exchange of creative ideas and good educational practice across the European Union;
- innovative database and content management system;

7 http://scienceduc.cienciaviva.pt/
8 http://www.xplora.org/ww/en/pub/xplora/nucleus_home/esti.htm
9 http://www.eurovolvox.org/

- networking with and support of local education organisations, scientific and wider communities;
- the team of working teachers, scientists, educational specialists and professional science communicators assembled.

3.4.1.4 CISCI Cinema and Science[10]

The following elements are identified as good or best practise:

- the use of media to raise the attractiveness of science while dispelling misconceptions
- the productive collaboration between teaching professionals
- the tackling of gender-stereotyped representations of science and scientists
- the address of public ethical and risk concerns
- the engagement with professional bodies

3.4.2 Projects from the GRID database

3.4.2.1 "Physics on show" project, I.T.I.S. Maxwell school , Turin, Italy[11]

The following elements are identified as good or best practise:

- The integration with the school development plan
- The integration with the larger set of pilot projects "La Scienza Amica"
- The role of students in conceiving, planning and realizing experiences
- The use of students in the role of tutors (active citizenship)
- The pedagogical sequence
- The playful approach to learning
- The particular attention paid to encourage students to develop some aspects of their individual personality

3.4.2.2 Quand les sciences font leur cinema[12]

When sciences organise cinema (Belgium, French-Speaking Community)

The following elements are identified as good or best practise:

- The awareness raising of the image that is created by filmmakers of science, of scientists and of scientific achievements

10 http://www.cisci.net
11 http://www.grid-network.eu/initiatives_view.php?id=99&lang=en
12 http://www.atoutsciences.be/index.htm

- The critical reflection by young people on the contribution of sciences to the development of our present-day society
- The drafting of dissertations and presentations

3.4.3.3 Inter-(t)asking: students learn from students (Austria)

The following elements are identified as good or best practise:

- Peer learning
- Treatment of information in an active way
- Collecting of experiences
- The resulting action-research project

3.4.3.4 Students teach their parents, England[13]

The following elements are identified as good or best practise:

- Involvement of parents
- Arrangement and management by students

13 http://www.specialistschools.org.uk

3.5 Synthesis and Comparative grid of the programmes and projects

The comparative grid below can be said to be a synthesis of the different programmes and projects.

Of course, one has to be aware that the nature of the initiatives mentioned is different. Some are national initiatives set up for whole countries which very often have started as smaller pilot projects. Others are international or European initiatives. Still others are more regional or local projects which are more or less independent but, in some cases, they may have links with larger initiatives or support structures.

It has to be stressed that the large national initiatives are all translated into hundreds or even thousands of smaller projects which would, at their level, contain, many of the 10 key characteristics of innovation.

This comparative grid has to be used with caution as it is drafted after having read and analysed only the information which is available on the different websites of the projects. A more through analysis would require an in-depth analysis based on interviews and more detailed study.

The marks used:

●●● = excellent

●● = very good

● = good

It is quite normal that all the programmes and initiatives mentioned in the deliverable get the marks 'Excellent' or 'Very good' as all of them in one way or another are linked to explicit innovative initiatives which were initiated to improve the quality of and innovation in science education.

Projects / programmes Innovation characteristics	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
NATIONAL INITIATIVES										
Lamap (FR)	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●
EIST (FR)	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●
Sinus transfer (DE)	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●
Sinus transfer Primary schools (DE)	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●
DeltaPlan : science and technology (NL)	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●
NAT (NO)	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●
CHIK (DE)	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●
EUROPEAN :/ INTERNATIONAL										
ECOSCHOOLS	●●●	●●●	●●	●●●	●●	●●	●●	●	●●	●●
NUCLEUS	●●●	●●●	●●●	●●●	●●●	●●●	●●	●●●	●●	●●
Pencil	●●●	●●●	●●●	●●●	●●●	●●●	●●	●●●	●●	●●
Heureka	●●●	●●●	●●●	●●●	●●●	●●●	●●	●●	●●	●●
Nemo; Science	●●●	●●●	●●●	●●●	●●●	●●●	●●	●●	●●	●●

Centre at school										
Exciters	●●●	●●●	●●●	●●●	●●●	●●●	●●	●●●	●●	●●
SCIENCEDUC	●●●	●●●	●●●	●●●	●●●	●●●	●●	●●	●●	●●
ESTI	●●●	●●●	●●●	●●●	●●●	●●●	●●	●●	●●	●●
VOLVOX	●●●	●●●	●●●	●●●	●●●	●●●	●●	●●	●●	●●
CISCI	●●●	●●●	●●●	●●●	●●●	●●	●●	●●●	●●	●●
LOCAL/ REGIONAL										
Physics on show (IT)	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●
Quand les sciences font leur cinema (Bfr)	●●	●●	●●	●●	●●	●●	●●	●●	●●	●●
Inter-(T)asking (AT)	●●●	●●●	●●	●●●	●●●	●●●	●●	●●●	●●●	●●●
Students teach their parents (UK)	●●●	●●●	●●●	●●●	●●●	●●	●●	●●●	●●	●●

4. Conclusions

The following conclusions can be drafted from the comparison of the projects mentioned above and from the other information mentioned in this deliverable. Overall, it has to be stressed that all the initiatives are high quality initiatives as they get a very high score on most, if not all of the items of the quality and innovation characteristics mentioned earlier.

No major distinctions can be made between the NUCLEUS projects and the Pencil projects at this stage. To be able to do so, a more detailed analysis would have to be done of all the Projects that make up together NUCLEUS (of which Pencil) and of the sub projects of Pencil.

However it can be said that all the information on the sub projects of Pencil was carefully read and analysed and that those presented in the deliverable – Heureka, Xciters and Science Centres at school from Nemo - were selected as they seemed to highlight most the key characteristics of quality and innovation stressed by the deliverable of WP 2 D 28 of the Pencil project.

It is also interesting to point out the quality and innovation characteristics used within NUCLEUS, Pencil and the Socrates action 6 GRID project (Innovation and observation project).

A distinction can be made between the 10 key characteristics outlined earlier as to the way in which the selected projects mentioned above respond to those criteria.

4.1 Five excellent characteristics

For the following five it can be said that most of the projects score an excellent. These are:

- Teachers are involved in the design phase of education projects aimed at schools; the involvement in the project is part of professional development; reluctance to change and resistance to change are addressed;

- Evaluation / assessment forms an integral part of the educational project of the whole school; assessment of theoretical work and practical work; integrated assessment of competences, knowledge and attitudes acquired through the project activities are part of the project;

- Contemporary understandings about learning and mediation are incorporated into projects; a special focus on the inquiry-based method and on integrated science teaching and learning; more effective and attractive learning methods are pursued;

- Contemporary views about the nature and practice of science are promoted by projects;

- Changes in competences, attitudes and motivation towards science are included in measures of efficacy alongside knowledge gain and levels of enjoyment;

4.2 Five Very Good or Good characteristics

For the last five characteristics, the scores can be said to be good to very good but further progress can be made in the following areas:

- Project impact is enhanced as a result of reciprocal partnerships and involvement with networks or communities or authorities. Partnerships and networks in various forms do not yet play a key role in projects. More focus should thus be given on the development of networks and partnerships in a win-win perspective for all partners. The active role of parents can definitely also be improved.

- The sustainability of the initiatives of the project or initiatives. Experience shows that initiatives and programmes which get a temporary financial support either at national, regional or European or international levels tend to have sustainability problems. Sustainability also has to do with the integration of projects into the school development plan and the constant professional development. Sustainability also has to do with the link between innovation in science education and innovation of the school at all levels. More research should be done to look more carefully into those issues.

- Issues of social inclusion and gender equity are addressed by some projects. Few projects focus on low achieving pupils or on "second chance initiatives in science." Only a few projects focus explicitly on active citizenship through e.g. peer learning models or mentoring / tutoring models. The analysis of the NUCLEUS and Pencil projects, plus the analysis of the 350 GRID projects show that very few science projects are addressing the target group of pupils in disadvantaged social situations. There seems to be a lack of interest to develop projects to promote science with pupils in disadvantaged areas such as children of migrant origin, Roma children etc.

- Action-research based on the innovative projects does not always seem to be explicitly present. It is not clear in how far the innovative project contributed to enhance the teacher to be reflective and which tools are used to enhance the reflection by the teacher as part of the overall strategy of an innovative school. Action-research should be promoted in every innovative school as a key characteristic to build the school development plan on.

- Not all the projects are post of comprehensive education initiatives at regional or national level to promote science education. However, it is not always clear if projects or initiatives on a local or regional level, link up with national innovation initiatives in education in general or science education in particular. It is not clear how certain projects link up with the development and implementation of a pilot programme in MST which includes needs analysis, implementation, monitoring / follow-up /support and evaluation of the projects plus the valorisation and mainstreaming in the whole education system. The big projects, programmes and initiatives seem to have those entire key elements abut it is not evident that smaller projects have those elements. Furthermore, it should be looked into if initiatives or projects created outside official programmes that exist in certain countries make efforts to link up with the official programmes so as to create synergy and cross-fertilisation.

5. Recommendations

5.1 Valorisation of the key characteristics of quality and innovation developed by Pencil

It is strongly recommended that Pencil deliverable D28 is largely valorised within the science education community in Europe and beyond. The present text could also be taken on board during such valorisation exercises. Valorisation of innovative developments in science education should be implemented at local, regional, national and European level building on partnerships involving all the key stakeholders that are linked to science education. The role of the MST cluster should also be strengthened when it comes to dissemination and valorisation. Major funding should be made available for theses activities in the framework of the 7FP of the EU under the Science in society part14. Valorisation will definitely also be enhanced to more partnerships and networking within the science education community and beyond at all levels. Developing more partnerships involving different stakeholders will definitely also lead to more sustainability of projects and initiatives.

5.2 Cooperation between key project promoters and the MST cluster has to be promoted

It is strongly recommended that towards the immediate future there is a stronger interaction between major project promoters such as those running Pencil and the Cluster on maths, Science and Technology. More interaction will on the one hand enable the concerns of the fieldworkers to be channelled to policy makers and the concerns of the policy-makers to be brought to those working at grassroots level. Strong cooperation and interaction will be beneficial in the areas of dissemination, valorisation and cross-fertilisation of the outcomes of projects. It will enhance mainstreaming innovation in science education across Europe and even beyond.

5.3 Synergy with other projects and initiatives in the field of science education and with innovation in general

Pencil could see to it that its projects are, if at all possible, linked to or integrated into large mechanisms or linked to mechanisms that promote systemic reforms. To this effect links have to be made with official systematic reforms implemented in several countries across Europe. Thus links should e.g. be made with the Delta Plan on science and technology in the Netherlands, or the Main à la Pâte initiative in France.

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14 Full information on the 7th FP see the brochure on the website: http://ec.europa.eu/research/fp7/pdf/fp7-factsheets_en.pdf

5.4 Focus more on social inclusion social cohesion and active citizenship issues in science education

It is definitely recommended that more attention is paid to the social cohesion, inclusion and active citizenship aspects in relation with science education. France is possibly the country that has the strongest social cohesion, inclusion and active citizenship focus through science education. This focus has to be promoted as it can make a major contribution to the European society of the future.

Studies should be started up linked to projects which focus on social cohesion and active citizenship issues for the different beneficiaries. On the one hand the beneficiaries can be pupils in disadvantaged areas and on the other hand the beneficiaries can be pupils, students or teachers that can be involved in mentoring or tutoring activities that support pupils in disadvantaged areas.

Science projects promoting active citizenship through mentoring or tutoring of pupils are simultaneously a contribution to social entrepreneurship which is one of the three components of entrepreneurship next to economic or business entrepreneurship and personal entrepreneurship.

It is also strongly recommended that more projects in science education should be focusing on the promotion of science with youngsters in disadvantaged situations.

5.5 Focus more on the contribution of science education to the acquisition of the 8 key competences

It is also very important that more focus is still given to science projects that next to promoting sciences also promote the 8 key competences for lifelong learning decided by the European parliament and the Council of Ministers in 2006. This happens already in several projects but it should really be generalised. The awareness should be raised, supported by research, that science education contributes, the learning, speaking and writing of the mother tongue (especially with disadvantaged groups) . That it contributes to foreign language learning. That it enhances entrepreneurial skills; social and civic skills (see what was mentioned above about citizenship). That it enhances digital competences as many science projects use ICT in various ways. That it enhances cultural competences in the broadest possible way.

5.6 Stronger focus on action-research in science education in schools

Although there is in a certain number of projects a focus on action-research and on the teacher(s) reflecting on what they are doing in the classroom with their pupils, one cannot say that this is a clear and general tendency. Only in a few science programmes there is explicit attention for action- research and teachers are helped to integrate action-research into their school development plane and into their professional development. This is definitely the case of the Austrian IMST2 programme[15] of the Inter-(T)asking project is a concrete example. Hence it is strongly recommended that more attention is paid to action-research in science education and that the networking of teaching in learning communities explicitly focus and build on the action-research done in separate schools or in joint projects. Cooperation with universities and initial and in-service training institutions will contribute to achieving what is suggested in the Communication of the Commission of the summer 2007 as to the quality of teacher education.[16]

15 IMST2 see the website:
http://imst2.uni-klu.ac.at/english/

16 Improving the quality of teacher education: see website:
http://ec.europa.eu/education/com392_en.pdf

Annex A: Recommendations of the MST Working Group

Interim recommendations 2003

From *http://europa.eu.int/comm/education/policies/2010/doc/maths_sciences_en.pdf*

The MST Group has identified 'compulsory education' as the top priority sector for action, since it has the central role in the education systems.

No single campaign or initiative is likely to ensure the long term future success of MST. All promising initiatives should **be part of a systemic reform** which will focus on the development of interpretation and understanding along with acquiring the requisite knowledge and skills at all levels and in all sectors of primary and secondary schools.

- Mathematics, scientific and technology education should be an **entitlement for every child and introduced at an early age.** It should be mandatory at all levels of compulsory education.

- **More effective and attractive teaching methods** should be introduced in mathematics, scientific and technical disciplines at primary and secondary level, in particular by linking learning to real life experiences, working life and society, and by combining classroom-based teaching with appropriate extra-curricular activities (participation in science fairs, festivals, competitions, excursions, science camps, visits to science museums, encouraging the study of appropriate scientific journals, 'inquiry' learning, etc.).

- **The professional profile and practice of MST teachers should be further enhanced**, not only by providing them with opportunities and incentives for updating their knowledge of content, but also by developing the didactics of MST and improving the teaching resources available. Improvements to the provision of effective initial and in-service training are needed, as well as providing incentives and special measures for sustaining the long term engagement of teachers. This will require investment of the necessary resources at all appropriate levels.

- **The needs of special groups (both high and low achievers and young people from different ethnic backgrounds) should be addressed**, and the appropriate measures taken to respond to gender-specific attitudes to mathematics, scientific and technical subjects. Teaching methods, pedagogical tools and assessment procedures should be refined and adapted to take account of these specificities.

- **Strong and effective partnerships between schools, universities, research institutions, enterprises, parents and other actors should be strongly encouraged**

and supported at all levels, both in order to improve the quality and 'user-friendliness' of teaching and with a view to preparing young people more effectively for working life and active citizenship. In this collaborative process, the leading role of universities should be recognized and supported.

Recommendations of the 2004 MST report

The 2004 report quotes that *"The first results of the 'mapping' exercise, along with the work carried out by the Subgroup on partnerships and the preliminary conclusions of the good practices in this field (2004), suggest some areas for action in MST in view of improvements as regards technology in curricula, needs of low-achieving pupils, gender balance, MST connected to real-life context, activity-based teaching, access of teachers to resource centres, but also their reluctance to adopt new didactics, valorisation of practical work in the assessment procedures, and finally the role of parents.*

Moreover, in its 2004 recommendations, the Working Group MST restates the need for education policies in the area of MST to assign priority to education pedagogies involving meaningful practical applications and ensuring the active participation of learners."

The 2004 recommendations are the following ones:

- **Curricula should clearly take into account the important role of Technology education**, which should be addressed as a field in its own right within MST. Technology education should be seen as different but complementary to science education.

- **The needs of low-achieving pupils in MST should be addressed** specifically by implementing MST curricula that are appropriate to their needs, abilities and interests, by providing more opportunities for practical activities and by introducing initiatives such as special classes, inclusion measures, appropriate textbooks and materials, etc.

- It is essential that policies tackle the problem of **gender imbalance in MST**, either through general policies designed to address equal opportunities and/or through specific measures (at teacher training level, through revision of didactical materials, special programmes to appeal specifically to girls, etc.).

- **Pedagogy is a crucial area for decision-makers** to address if MST subjects are to improve in effectiveness and attractiveness. Measures should therefore be taken to connect more systematically MST teaching to real-life contexts and experiences; Teachers should be provided with the means (in time and resources) to do so, especially through extra-curricular activities. As the most effective pedagogies are time-consuming, time devoted to practical activities should be reorganised in order to improve the effectiveness of teaching and learning. One possibility would consist of moving from 'content'- to 'activity'-based teaching and foster pupils' curiosity while avoiding the overcrowded curriculum.

- **Policies should address the perceived reluctance of teachers to adopt new didactics** in the field of MST and find ways and means, in particular through the dissemination of good practices, to change the situation. Teachers should also have access to resources centres supporting the development of new innovative pedagogical methods.

- **Pupils' assessment procedures should give importance to both theoretical and practical work and promote new teaching methodology**.
- Any measure taken (at policy level or through the development of specific initiatives / partnerships) to increase interest and participation of pupils in MST, and in particular girls, should foster the **participation of parents** in order to help them overcome their prejudice vis-à-vis these fields.

- **Partnerships/initiatives aimed at providing "second chance" opportunities** for those who did not opt for MST subjects should be developed.

- **Partnerships between schools and universities to increase interest and participation in MST should be made more frequent**. Universities, and higher education institutions, should have the adequate means (both human and financial resources) to cope with potentially large demand that might arise from schools.

Recommendations made in 2004 by the sub group cooperation between schools and universities

- The Subgroup recommended that efforts should be made 'to promote the creation of **new positions for MST education in higher education institutions'.**

- Governments should encourage **schools to liaise with universities, parents associations, and industry** on MST subject development.

- **Second-chance opportunities** were considered as good potential methods for inspiration in establishing partnerships and should therefore be supported.

- Member States should promote and/or update '**school development plans' for MST**.

- **Partnerships should be seen as 'equal opportunities and reciprocal partnerships'** – universities should be able to learn from school partners and school partners from universities.

- **Alliances should be formed between stakeholders** so as to ensure equitable access pathways to training programmes and employment in the field of MST.

Annex B: Pencil Criteria of Innovation

From Pencil deliverable D28 Criteria of Innovation

Criterion 1: Teachers are involved in the design phase of education projects aimed at schools

Indicators

- Museum / science centre staff commit time and resources to recruiting partner teachers
- Museum / science centre staff work closely with teachers to ascertain their needs, requirements and expectations
- Front-end evaluation tools are used as a systematic way to collect teachers' views.
- Discussions about pedagogy form an important part of project planning
- The professional development of teachers is an explicit goal of the partnership

Criterion 2: Evaluation forms an integral part of the educational project

Indicators

- Regular reflection on use of tools, and on advice of experts in evaluation
- Barriers to success are communicated in evaluation reports alongside achievements
- Project budgets are strategically apportioned to evaluation
- Evaluation results from across the field of science learning are shared

Criterion 3: Contemporary understandings about learning and facilitation techniques are incorporated into projects

Indicators

- Approaches to teaching and learning employed by museum and science centre educators complement those used at schools
- A range of facilitation techniques are employed by museum and science centre staff and teachers
- Target content is combined with other topic areas

Criterion 4: Contemporary views about the nature and practice of science are promoted by projects

Indicators

- The nature of science forms a key part of the topic(s) addressed in the project
- Scientific content is contextualized: science is a human endeavour

Criterion 5: Changes in attitudes and motivation towards science are included in measures of efficacy alongside knowledge gain and levels of enjoyment

Indicators

- Interests of students are actively solicited when designing content of the project, or aspects of the activity
- The project aims to enhance attitudes towards, and interests in, science

Criterion 6: Impact of project is enhanced as a result of involvement with networks or communities

Indicators

- Museums / science centres are involved in professional networks
- Local networks are established

Criterion 7: The initiative is sustainable

Indicators

- Lessons learnt during one project are applied to other projects
- New audiences are reached
- New expertise is fostered by the project
- Core/high impact areas are addressed by the project
- Opportunities to extend the initiative beyond the initial funding period are researched and fostered
- External funding is received

Criterion 8: Issues of social inclusion and gender equity are addressed by the project

Indicators

- Target audiences are selected with deliberate reference to issues of social inclusion and equity
- Methods of learning and teaching should reflect contemporary views with respect to equity and inclusion
- Evaluation strategy seeks to capture issues relating to social inclusion , equity and gender differences
- Project findings and insights are shared broadly across a range of dissemination channels

Annex C: The Rocard Report: *Science education now: a renewed pedagogy for the future of Europe!*

From http://ec.europa.eu/research/science-society/document_library/pdf_06/report-rocard-on-science-education_en.pdf

Findings

A reversal of school science-teaching pedagogy from mainly deductive to inquiry-based methods provides the means to increase interest in science.

Inquiry-based science education (IBSE) has proved its efficacy at both primary and secondary levels in increasing children's and students' interest and attainments levels while at the same time stimulating teacher motivation. IBSE is effective with all kinds of students from the weakest to the most able and is fully compatible with the ambition of excellence. Moreover IBSE is beneficial to promoting girls' interest and participation in science activities. Finally, IBSE and traditional deductive approaches are not mutually exclusive and they should be combined in any science classroom to accommodate different mindsets and age-group preferences.

Renewed school's science-teaching pedagogy based on IBSE provides increased opportunities for cooperation between actors in the formal and informal arenas.

Due to the nature of its practices, IBSE pedagogy is more likely to encourage relationships between the stakeholders of both formal and informal education. And it creates opportunities for involving firms, scientists, researchers, engineers, universities, local actors such as cities, associations, parents and other kinds of local resources.

Teachers are key players in the renewal of science education. Among other methods, being part of a network allows them to improve the quality of their teaching and supports their motivation.

Networks can be used as an effective component of teachers' professional development, are complementary to more traditional forms of in-service teacher training and stimulate morale and motivation.

In Europe, these crucial components of renewal of science teaching practices are being promoted by two innovative initiatives, "Pollen[17]" and "Sinus- Transfer[18]" that are proving

17 The POLLEN project: Seed cities for science; see the website: http://www.pollen-europa.net/?page=CLDGDJVwskY%3D
18 The SINUS Transfer programme: see the website: http://sinus-transfer.uni-bayreuth.de/english_version.html

themselves capable of increasing children's interest and attainments in science. With some adaptation these initiatives could be implemented effectively on a scale that would have the desired impact.
The level of funding required is in accordance with the scope of the funding instruments of the European Union.

Recommendations

Recommendation 1:
Because Europe's future is at stake decision-makers must demand action on improving science education from the **bodies responsible for implementing change** at local, regional, national and European Union level.

Recommendation 2:
Improvements in science education should be brought about through **new forms of pedagogy: the introduction of inquiry-based approaches in schools, actions for teachers training to IBSE, and the development of teachers' networks** should be actively promoted and supported.

Recommendation 3:
Specific attention should be given to raising **the participation of girls** in key school science subjects and to increasing their self-confidence in science.

Recommendation 4:
Measures should be introduced to promote the **participation of cities and the local community in the renewal of science education in collaborative actions** at the European level aimed at accelerating the pace of change through the sharing of know-how.

Recommendation 5:

The articulation between national activities and those funded at the European level must be improved and the opportunities for enhanced support through the instruments of the Framework

Programme and the programmes in the area of education and culture to initiatives such as Pollen and Sinus-Transfer should be created. The necessary level of support offered under the Science in Society (SIS) part of the Seventh Framework Programme for Research and Technological Development is estimated to be around 60 million euros over the next 6 years.

Recommendation 6:

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

Annex D: La Main à la Pâte

From www.lamap.fr

Key elements for the Main à la Pâte initiative are:

As to the contents:

- inquiry-based approach, develop hypotheses, experimentation, testing, collective reconstruction to raise interest and motivation for sciences
- pupils are the key actors, teachers are coaches
- stimulating reasoning, critical thinking, democratic debate,
- mastering of the mother tongue both spoken and written
- acquiring various key competences and skills through science teaching and learning and
- overcoming social barriers., promoting social cohesion and inclusion
- science linked to developments in society
- the development of open-source contents

As to the support structure:

- Strong cooperation between Lamap and the Ministry of national education of France
- large dissemination, valorisation and training of teachers
- strong networking of all those involved in the renovation
- the cooperation with the scientific community
- he cooperation with the local, regional community and authorities
- development and sharing of (jointly) developed pedagogical and didactic tools and instruments
- scientific and pedagogical coaching; through scientific consultants and through the support of a network of 15 pilot resource centres in France
- transfer of expertise and training towards other interested countries; international cooperation and exchange
- the support of a high quality interactive website

The inquiry-based approach

The key to the innovative method is the inquiry-based approach. Children are invited to investigate a scientific problem in a structured way involving several (pedagogical) steps.

The enquiry-based approach is composed of the following phases:

- activate the curiosity of the pupils, raise the interest and curiosity of the pupils for a scientific problem or challenge;

- move from the state of curiosity towards an educational project; invite pupils to express in words what the problem is about; the use of language is key at this stage to define the problem or challenge;
- from the definition of the problem to planning the inquiry-based project; defining the steps to be set to implement the project;
- Implementing the project activities planned; this is usually done in various different ways (tests, experiments) according to the teachers in the classroom;
- When the activities are implemented comes the confrontation of the results with the reality; comparing the concrete results or outcomes with the expected results; individual or collective validation of the outcomes is part of this phase;
- Conclusions are drawn highlighting which scientific knowledge has been acquired; possible links are made with new scientific problems;
- Making the link between science and ethics, technology, (political) decision-making, the making of choices.

By prompting pupils to use argument, whether oral or written, this process takes part in language learning, in acquiring an independent attitude that is heedful of others. It is based on teachers achievements, the networking of their skills and the creating of effective synergies with external actors, inspectors and educational advisers, college of education training staff (IUFM[19]), teaching specialists in science and other subjects, scientists, researchers, engineers, students from science universities or from the national colleges (Grandes Écoles[20]), parents.

Many teachers experience a privileged opportunity of working as a team, see the opportunity to give meaning to their action and point this out. In many classes considered as "difficult" they have managed to mobilize their pupils who have discovered a completely new awareness of self-control and control over their surroundings. The experiment, which was extended **from 5000 classes to some 350.000 of classes** since 1996 has, since May 1st 1998, been given the supplementary benefit of an Internet site which not only provides opportunity for exchanges between colleagues, for dialogue between scientists and teachers but also the availability of numerous helpful resources.

[19] **IUFM *(Instituts universitaires de formation de maîtres)*** *:* University institutes of teacher training. The framework law on education, dated July 10 1989, created one IUFM in each académie. They are State institutions of higher education which, in 1991, replaced the former teacher training institutions for primary and secondary education: ecoles normales d'instituteurs, regional teaching centres, national ecoles normales for apprenticeship, and training centres for technical teachers. Each institute is attached to one or several universities or other State institutions of learning, whether scientific, cultural or vocational. In 1990)-91, three IUFMs were opened experimentally in Grenoble, Lille and Reims. on June 17 1991, 25 other IUFMs were created by Decree, so that since the autumn term 1991 there has been one institute for each of the 28 académies in France and the 29th, in the Pacific in 1992.

[20] **Grande école** *(grandes écoles) :* Etablissement public ou privé d'enseignement supérieur. L'admission dans les grandes écoles est soumise à une sélection rigoureuse sur concours après deux années dans une classe préparatoire aux grandes écoles (CPGE) implantée dans un lycée ou sur dossier après le baccalauréat. Les grandes écoles forment des diplômés de haut niveau (ingénieurs, gestionnaires, chercheurs...).

Difficulties in promoting and implementing the inquiry-based approach:

- the fear of primary school teachers of doing experimental work in the classroom;
- the resistance against innovation: fear of the unknown;
- the fact not to be trained to be involved in active pedagogy
- the fact that the hierarchy of the school is not always convinced that science teaching is useful as a contribution to different other aspects of education.

Link between the pilot project Lamap and the PRESTE national innovation

The Main à la Pâte initiative can be seen as a key pilot project for the promotion of science education as it was the basis for the generalisation of this innovative approach by the Ministry of national education. Indeed in June 2000, the French Ministry of Education decided to let all schools benefit from the expertise acquired within the framework of La Main à la Pâte by setting up a **plan for the renovation of science and technology teaching at primary school level (PRESTE).** This plan, independent from the initiative in itself, takes its expertise into account and integrates it as an innovative pilot project. La Main à la Pâte" keeps its own dynamic as well as its own features, namely linking with scientific partners and networking participants for a better exchange in the field.

The cooperation with the scientific or research community

Cooperation with the scientific or research community takes different forms:

- **The network of scientific consultants** is composed of some one hundred voluntary scientists (researchers and engineers) that help primary school teachers that have questions or meet difficulties in implementing their science lessons. A coordinator dispatches the questions received to the appropriate scientist or researcher so as to provide the teacher with the best answer. Efforts are made to formulate the answers in concrete easy language.

- **The cooperation with institutions of higher education** (mainly engineering schools) through which **engineering students act as tutors** and go and support primary school teachers in the classroom. The idea is not that those student replace the teachers but that they support them especially in the area of the scientific contents and concepts. They also act **as role models** for the children with whom they are in contact. The students involved in those activities are trained to do so. They may also get credits for the work they do as it is considered (in some cases) as part of a subject that could be called 'Social or societal entrepreneurship.

A large support team + 15 resource centres

In order to realize this objective, the Academicians have also the support of a team of around **fifteen full time persons** (Lamap team), of a Scientific Council composed of outstanding persons of research and education, and of a Committee of partners which is intended to give ideas and financial support to the action of the Académie.

From the beginning, a number of partners were sought, **actions were initiated and tools created**. At the same time, stimulating relations have been established with foreign colleagues working in the same vein, thus leading to collaborations and enriching comparisons. On all these points the Académie has contributed greatly to the progression of these ideas and to the facilitation of contacts between the partners in the operation.

The creation, development and implementation of **15 pilot resource centres** is very import for the support which is given to schools in implementing La Main à la Pâte. They organise training, they go into schools to help teachers, they can welcome teachers and their pupils in the resource centre to do experiments. They can also cooperate with the pilot schools to disseminate the innovative inquiry-based pedagogy towards other schools.

The representatives of the 15 centres also meet on different occasion to share experiences and strengthen their work the schools. The resource centres are also strongly cooperating with the local authorities that in some cases support the centres by giving them financials support for the equipment; All of them are linked to other local partners such as institutions of higher education, research centres etc. to strengthen their activities.

An Internet network and website(s): http://www.lamap.fr

The Académie has undertaken **to provide French schools with an Internet network**, enabling the teachers involved in La main à la Pâte, to link up with one another, and also linking them to the world of research.

The Website, which has three sections (information, resources, exchanges), has several attached networks:

- **the La main à la Pâte network**: a national site and departmental sites display locally produced resources and general information,
- **the network of scientific consultants** where researchers and engineers answer science questions raised by teachers,
- **the network of training officers/teaching specialists** on which questions on teaching and education are dealt with.

Next to the official website of the Lamap there are the so-called **mirror websites** which are websites started up by some of the international partners. Access to the mirror websites is available on the Lamap website

Several pedagogical activities are supported by the Académie des Sciences :

- in the beginning the **availability of educational documents** corresponding to the approach described here was only fragmentary, American Hands on texts have been translated and made available to teachers on the site. Then, the generation of texts, books, experimentation packs.... has been encouraged. A **'Seal of approval committee'** has been created. Chaired by the academician Marc Julla, it examines documents seeking to achieve the La main à la Pâte, seal, which guarantees their good scientific quality.
- **an Autumn University** has been founded, with the support of the Fondation des Treilles, which brings together schoolteachers and researchers. The reports of the latter are published in the Graines de sciences collection, as scientific texts for primary school teachers and parents.
- **La main à la Pâte prizes** are awarded annually by the Académie to classes for high-quality achievements in science teaching and learning.

Project partners

The first of Académie's partners has of course been the **French national Ministry of Education**. The launch of La main à la Pâte in September 1996, was by Ministerial decision and involved 450 primary school teachers in five French départements. The number of teachers is currently more than 6000. Encouraged by the Department of School Education (Direction de l'enseignement scolaire, DESCO), the experiment led to the setting up by the Ministry, in June 2000, of a plan derived from La main à la pâte to revitalize the teaching of the sciences, in all French schools at cycle 3 (final two years of primary school), the idea being to then extend it to all primary education, including preschools.

The Instituts Universitaires de Formation des Maîtres (IUFM) are essential partners because that is where the teachers are trained. The Académie has established excellent relations with the lUFM, concretely through the creation of a network of La main à la pâte "corresponding members", with a presence in each Institute.

The Institut national de recherche pédagogique (INRP, National institute for educational research) has been involved from the beginning through research staff, IT support and more.

The Corps des Professeurs des écoles (the teaching body) is a crucial interlocutor for the Académie. This dialogue is established at numerous sessions, conferences, education days and other events when the promoters of La main à la Pâte, invited to talk science, receive comments and ideas in exchange.

The École normale supérieure bas thrown itself alongside the Académie in this approach, involving agrégation21 candidates (the highest competitive examination for teachers in France), and making offices available to the Lamap team.

A number of the Grandes Écoles have joined the movement: l'École des Mines de Nantes, which is generating educational material, I'École Polytechnique some of whose students spend a few months in schools in difficult areas; l'École de Physique et Chimie Industrielle de la ville de Paris, whose Director Pierre-Gilles de Gennes has encouraged it to be involved in scientific support of a number of schools in Paris.

Various Bodies and Associations, both public and private, support La main à la pâte, in diverse ways:
- the Department of Technology (Direction de la Technologie, DT) of the Ministry of Research, and the Interministerial Commission on the Town (Délégation Interministérielle a la Ville, DIV) have contributed to the financing of some of the Académie's activities,
- the Fondation des Treilles, with its hosting of seminars, and through the publication of books, has been a partner from the beginning, together with the Société Française de Physique, EDF (électricité de France), France-Télécom,...

Many Institutions are striving towards the popularization of science among children. La main à la Pâte has positive relations with a lot of them, for example: la Cité des sciences et de l'Industrie (la Villette) and Le Palais de la Découverte (Paris).

In a less institutional way, **many laboratories and research centres**, together with engineers and researchers (both active and retired), lend a valuable support, generally involving actions in schools or on the Internet site.

Various collaborations

Finally, the Académie has established a large number of collaborations on the necessity to revitalize the teaching science systems, because IAP (InterAcademy Panel) has made this theme of its priority tasks.

[21] **Agrégation :** A national competition for the recruitment of teachers, which gives access to the corps of agrégés in secondary education and in university, who belong to the civil service. There are separate competitive examinations for the agrégation for secondary schools and that for universities, which only exists in certain subjects.
Agrégé *(agrégés) :* A teacher in secondary or higher education who has passed the agrégation examinations for secondary or higher education. Secondary school agrégés teach mostly in Lycées and sometimes in collèges, in preparation classes for grandes écoles (CPGE), in IUTs, in STS and sometimes in universities. Agrégés in higher education who are appointed to university professorships, teach in higher education.

The Main à la Pâte initiative also has a very clear international perspective as it cooperates with numerous foreign countries in Europe and across the world that have resolutely involved themselves in this teaching and learning method. The French Ministry of Foreign Affairs is an important partner of the Académie for the international part of the operation. Among these collaborations, it is particularly pertinent to mention those established with Brazil, China, Columbia, Egypt, Israel, Morocco, Mexico, the United States, Vietnam. and, more generally, with the ICSU (International Council for Science) through the CCBS (Committee on Capacity Building for Science). One sign of this broad opening up is that the book La main à la Pâte, (Flammarion, 1996) has been translated into Arabic, Chinese, Portuguese and Vietnamese (translations in Spanish, Hungarian and Romanian being in preparation).

Annex E: The PRESTE reform

The PRESTE, Plan de Rénovation de l'Enseignement des Sciences et de la Technologie à l'Ecole or the Plan for the renovation of the teaching and learning of sciences in the primary school (abbreviated in French to PRESTE) was developed and implemented in order to **promote within the primary school an approach based on scientific investigations**. The idea is to propose to the curiosity of the pupil objects and phenomena of the world surrounding them and to articulate or link to one another scientific learning, the use of mathematics and use of the numerical world. In this way this programme builds upon the underlying philosophy of the Main à la Pâte initiative, initiated by **professor George Charpak, 1992 physics Nobel Prizes,** and member of the Academy of Sciences.

The renovation in the teaching of sciences intends to give to all the pupils the basic elements of science education described in the school programmes.

- The pupils observe a phenomenon and formulate their questions.
- They imagine and implement experiences; they document themselves.
- They exchange and argue amongst themselves; they confront their points of view and formulate their results orally and in writing.
- They confront their results to established knowledge.
- They learn to listen to each other, to respect each others' point of view and to take into account the advice of others.

The timetables and programme of the primary school were defined by law on 25 January 2002[22]. They entered into force at the beginning of the school year 2002-2003 for the elementary course 1st year, at the beginning of the school year 2003-2004 for the preparatory course and for the middle course 1st year, at the beginning of the school year 2004 – 2005 for the elementary course 2nd year and the middle course 2nd year;

The programmes of the primary school, divided into fields, distribute the teaching of sciences in the fields of "Discover the world" in cycle 2 (CP and CE1) with a weekly timetable of 3 to 3, 5 hours and "Scientific Education" in cycle 3 (CE2, CM1 and CM2) with a weekly timetable of 2,5 to 3hours.

To bring about such a through in-depth renovation of science teaching and learning all the levels and all the stakeholders of the educational system have to be mobilised and numerous partnerships have to be set up. It is important to reach a large cohesion with the different educational mechanisms and structures that exist in the country.
Although the PRESTE Plan is limited to the primary school, lower secondary schools can associate themselves to the plan for renovation.

[22] published in the BO out of series n°1 of 14 February 2002.

They can associate themselves to the PRESTE innovation by:

- Facilitating access of the pupils of the primary school to special science rooms and to scientific equipment in the lower secondary schools;
- Putting at the disposal of the primary school teachers the expertise of the specialised secondary school teacher.

Cooperation between primary schools and lower secondary schools also contributes to facilitate the transition from one to the other.

Support structures or steering committees

There are steering committees to monitor and steer the implementation of the PRESTE plan for renovation at national level (for the whole country), at the level of the Académie(more or less a Region) and at the level of the Départements.

At national level **a national steering committee of PRESTE** is the responsibility of the Ministry of national education (in particular of the DESCO). They are in charge of initiating and following-up all major phases of the implementation of the PRESTE plan. They make available credits for the equipment of schools involved in innovative projects and to strengthen the training of the teams involved. They disseminate and produce the pedagogical resources for teachers. They organise training seminars for the teams at the levels of the Académies and the Départements.

For each Académie (region) a steering group has also been set up. It has to guarantee that the PRESTE plan is implemented in a coherent way at the level of the Académie and has to develop support responding to the needs to reach the national objectives of the PRESTE plan. This steering group also includes representatives **of the departemental (Département) steering groups** which support the innovation at the level of the Département.

They have to mobilise the CRDP or Regional centre for Pedagogical documentation, the IUFM or initial teacher training institution. They have to stimulate the creation of partnerships with scientific community, the institutions of higher education, the universities, the research institutions, non profit organisations in sciences etc.

Thus the support to be given by the Académie mainly concerns documentation, expertise on pedagogical products, ICT training and mobilising the **partners of the scientific community**.

To this effect **each Regional Centre for Pedagogical Documentation (CRDP**) is associated to the implementation of the PRESTE plan.

The IUFM or initial teacher training institutions are important actors for the follow-up in each Académie as the training provided by the IUFM has to be in conformity with the requirements of the PRESTE plan.

It is hoped that the PRESTE plan also gets the support of the local authorities through support of the municipalities. As mentioned earlier it is also hoped that Collèges or lower secondary schools support the PRESTE plan

For the implementation of the new programmes, an important effort was made to support and help teachers by making available to them exercise sheets, knowledge sheets and other accompanying documents that can be downloaded from the site of the National Centre Of Pedagogical Documentation (CNDP)[23]. The programmes of the primary school are to be found on the Eduscol website24

Problems met for the implementation of the PRESTE plan

- It has been difficult to convince all teachers to apply the new programmes. At the moment one can say that approximately ¼ to 1/3 of the teachers have applied the new programmes. The margin of application differs widely across different areas.
- It is easier to motivate the primary school teachers to promote the PRESTE innovation than it is to motivate the teachers of the lower secondary school (collèges). Special efforts are made to train within as many primary schools as possible a resource teacher who can become a key actor to disseminate the innovation in his/her school or surrounding schools.
- 80% of the primary school teachers have no specific science teacher training; hence the importance of the support to be given to those teachers.
- The in-service training for teachers is not really working and autonomous learning is also minimal. Replacing primary school teachers that go on in-service training courses is difficult if not impossible in small schools.
- It has not been easy to network all the different partners or stakeholders concerned by the PRESTE plan. The universities participate badly in the renovation while the Grandes écoles (e.g. engineering schools) participate much better.

Students as tutors and mentors of primary school teachers

As students from engineering schools support primary school teachers in science teaching special attention is given to the following elements:

[23] http://www.cndp.fr/ecole/programmes/accueil.htm
[24] http://eduscol.education.fr/D0048/primprog.htm

- The training of the students to be 'mentors' or students. The students have to know they do not replace the teacher but support him. They back up the teacher in the classroom when it comes to specific scientific knowledge.
- The teacher also has to be prepared before they accept an engineering student as a support person in their classroom. The cooperation between the teacher and the student has to be prepared, followed-up and evaluated.
- Credit systems are developed so as to integrate the efforts and the time of the engineering students into their normal curriculum. Sometimes their investment can be up to six months in a school.

The full text of the PRESTE plan for renovation in science teaching and learning is available in French on the Education.gouv[25] website.

[25] http://www.education.gouv.fr/bo/2000/23/ensel.htm

Annex F: The EIST pilot project

The EIST or Enseignement Intégré de Science et de Technologie au Collège or integrated teaching and learning of sciences at the lower secondary school is an experiment or pilot project resulting from the partnership between the Ministry of Education and the Academy of Sciences: started in 2006[26]. At the moment two académies are involved in this experiment.

The **experiment,** within the framework of the **orientation law for the future of the school** and based on the implementation of the modernised programmes of scientific disciplines and on the definition of the common base of knowledge and of the competences was implemented at the beginning of the school year 2006-2007 in the sixth class of the Collège (lower secondary school) and is being implemented also now in the fifth class of the Collège. In most cases it was implemented for a trimester period; in some cases for the whole year.

It aims at:

- Developing the **pupils' curiosity** and giving them the taste of experimental sciences and of technology;
- Implementing the **investigation approach** prescribed in the new science programmes;
- Building an integrated scientific education implementing the programmes of three disciplines (chemistry-physics, Life and Earth sciences, technology);
- Facilitating the transition from the primary school to the first year of the lower secondary school (collège).

Bases for this experiment

- The **autonomy of the local public education institutions** ensuring major scope for initiative for the educational teams;
- The **willingness of the heads of schools and their pedagogical teams**, ready to take part in these experiments for a four-year period;
- An **appropriate and adapted support and training;**
- The **teachers' disciplinary competence and their willingness** to apply their competence within the framework of a broad vision of science and of technology;
- The **implementation of the experiment in a significant number of sixth classes** as from the first year onwards;

[26] http://www.academie-sciences.fr/enseignement/guide_06.pdf .

- The **creation of a multidisciplinary team,** to implement the project, including systematically teachers of the three disciplines: physics-chemistry, Life and earth sciences and technology, and possibly of other disciplines.

The operational objectives and the indicators for the lower secondary schools

The general objectives of the pilot project mentioned above can be translated into operational objectives within the collèges:

- The teachers of the three disciplines (chemistry-physics, Life and Earth sciences, technology) have to be associated in a common and joint work;
- Organise an integrated teaching of sciences and technology, given by one teacher during at least 30% of the school year (3,5 hours in the 6th form);
- Test the steps to be taken to involve up from the 6th form the teachers of physics and chemistry by adding half an hour to the timetable of the pupils.

To facilitate the monitoring and the comparison at national level, a common work will be set up to select indicators so as to measure to which extent the acquisition of knowledge and competences is promoted linked to science and technology and to measure if this integrated teaching of sciences has an impact on the number of pupils taking scientific and technological studies in the further years of the collège and the lycée.

Each pedagogical team that takes part in the pilot project has to define its characteristics and the directives for its work. A contract will be drafted that will mention, for each lower secondary school, the objectives to be reached by the pilot project, the modalities of the pilot, the means available, the persons involved, the partners to be associated, the support or monitoring to be envisaged and the evaluation to be carried out. The contract will also clearly mention that the pilot project will last four years. This contract will be signed by the collège and the recteur d'académie and will be revised on a yearly basis taking into account intermediate results, unexpected effects and contextual developments.

Annex G: The SINUS programmes

The SINUS TRANSFER programme : Steigerung der Effizienz des mathematisch-naturwissenschaftlichen Unterrichts (Increasing the Efficiency of Mathematics and Science Education)

The overall objective of this programme is to promote the quality and the efficiency of maths and science teaching and learning across Germany. The starting point for the project was the fact that in international comparison (e.g. TIMSS, PISA), the results of the German pupils were average, in mathematics in the bottom half. Yet, there are materials and models for good teaching. The Federal Government and the Länder have therefore launched the SINUS Programme for increasing the efficiency of teaching mathematics and the sciences into all schools nation-wide. 15 Länder had participated. Schleswig-Holstein had the lead, while the Leibniz Institute for Science Education (IPN) at Kiel University (head of project Prof. Dr. Manfred Prenzel) acted as project management agency.

The SINUS programme proposes a framework of quality development in schools comprising eleven modules: developing a task culture, working in a scientific manner, learning from mistakes , securing basic knowledge , cumulative learning , experiencing subject boundaries and interdisciplinary approaches , promoting girls and boys , promoting student co-operation , autonomous learning , assessing progress: monitoring and feedback and assurance All in all, 180 schools participated. Six schools each cooperated in a local network (a school-set), while one of the schools had an outstanding position as 'pilot school'. 30 such school-sets were set up nation-wide. On average, about five teachers actively participated in the programme at each school. The networks work together with regional universities and teachers seminars.

After five years (1998 - 2003), the BLK pilot project Increasing Efficiency of Teaching Mathematics and the Sciences (SINUS) was concluded on 29 April 2003 with a central final event in Berlin. The SINUS Transfer Programme was launched on 1 August 2003. Since 2003 it is continued in 13 Länder with 734 schools in the first two-year cycle. The objective of the transfer programme is to bring the results of the SINUS Programme for increasing the efficiency of teaching mathematics and the sciences into all schools nation-wide in Germany. The Federal Government and the Länder made available about €10 million.

The programmes ChiK (Chemie im Kontext ; see also information in this deliverable) and **PiKo** (Physiek imKontext) are linked to the SINUS Transfer programme. There is a special server and website used for publishing results and for retrieving information within the regional networks as well as nationwide. It informs about interesting materials and provides a platform for professional cooperation and scientific dialogue The results of two studies carried out in 2000 and 2003 confirm that the program has made a successful start. Stable groups have emerged within the school sets and started working together in accordance with the modular conception of the expert report. In the specialized school sets cooperation is target and product orientated.

Formative and summative evaluation competences are more and more developed in the participating school-networks. This cooperation not only extends across the regional school sets but also across the whole network. Certainly, the process to establish a new learning culture will take more than a few years. Permanent quality development practice has to be established in our schools nationwide.

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Website : http://sinus-transfer.uni-bayreuth.de/

SINUS-Transfer Grundschule (Increasing Efficiency in Mathematics and Science Education (SINUS) in Primary Schools)

The objective of the programme : Increasing Efficiency in Mathematics and Science Education (SINUS) in Primary Schools was as the title states very clearly, to increase the interest, motivation, efficiency and quality of maths and science education in the primary school across the different Länder of Germany. In August 2004 the federally sponsored programme SINUS-Transfer Primary School was launched in 11 federal states with 142 participating schools. During its five-year-duration its purpose is to increase the efficiency in Mathematics and Science Education.

The concept is based on the SINUS-approach that is transferred to a different type of school and a different level of education. Comparative school achievement studies (e.g. IGLU-E) show considerable differences in school performance at the end of primary school that are further aggravated in secondary school. Participating teachers work cooperatively at their schools as well as in their sets that consist of several schools in the same region. They improve their teaching by focusing on selected questions and problems.

Their work is based on a selection of ten modules. Focusing on the following elements: Developing a task culture, Working in a scientific manner, learning from mistakes, securing basic knowledge, cumulative learning, experiencing subject boundaries and interdisciplinary approaches, promoting girls and boys, promoting student co-operation, autonomous learning, assessing progress: monitoring and feedback and assurance Primary School is a type of school for all children. It is supposed to create a basis on which learning in German secondary schools can succeed.

The Programme is being evaluated repeatedly. The evaluations carried out have shown that the activities set up and disseminated within the framework of the SINUS Transfer project for primary schools have an impact on interest and motivation for science and maths and have an impact on the efficiency and the quality of the teaching of maths and science. See also the description of SINUS Transfer for the secondary school with further information.

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Website : http://www.blk-bonn.de/modellversuche/sinus-transfer-grundschule.htm

Annex H: The DELTA Plan

The DELTA PLAN: SCIENCE and TECHNOLOGY of the Netherlands[27]

Characteristics

The starting point of the Delta Plan Beta Science and Technology was the fact that the Netherlands want to become prominent knowledge economy, leader in the areas of education, research and innovation: economically competitive and socially innovative. In order to excel, the Netherlands needs a boost in science and technology making better use of technology and human talent, so as to successfully introduce innovations into society. Science and technology are powerful catalysts or growth and employment opportunities. Investing in science and technology brings rewards.

Scientists and technical experts are needed in all sorts of fields: not only outstanding academics doing ground-breaking research, but also professionals running production processes. There is a whole world to be won, extending beyond traditional technical sectors. The service industry, healthcare, media, entertainment, transport and logistics offer opportunities through better integration of science and technology to create smarter and more productive working processes and better services. This is an innovative movement with the characteristic features of a learning organisation. The Ministry is eager to provide interested schools, companies etc. with tried-and-tested concepts. At the same time, the ministry is open to being surprised by fresh ideas and unexpected alliances. This facilitates optimal use of our combined talents for innovation and growth.

Influence the choices of the young

Despite the good market opportunities, there are relatively few young people choosing to take science and technology subjects. Young children generally have a positive attitude toward science and technology subjects, but many give them up around age 14 or 15, partly due to the negative image that is given. Science and technology subjects are seen as one-sided, offering few opportunities for development. Moreover, in the current supply-driven education system, pupils have to make specific choices at a young age. That early selection is part of why many young people turn away from science and technology at an early age. Young people feel that a career in science or technology offers too little perspective. The social relevance of such professions is also not clear.

Pupil and career are key elements

It is crucially important to increase young people's interest in science and technology. From primary education to university, from vocational training to the business world: together, they face the challenge of making young people aware of the vast potential that

27 For further information see the website of Platform Beta Techniek: http://www.platformbetatechniek.nl/

science and technology offers in all areas of life. Together, an innovative education centred on the pupils and their talents can be implemented. With teachers who are alert to crucial points during young people's (school) career, e.g. when choosing a specialisation and study programme. Employers and sectors can offer more appealing careers and utilise their technological talents more effectively.

Focus on talent and innovation

The Science and Technology Platform (Platform Bèta Techniek) has the task of increasing enrolment into, progression through and graduation from science and technology subjects. That goal is achieved by offering a quality approach and customised solutions, with good, appealing study programmes – including new options - that meet the demands of the (future) jobs market – and by offering appealing jobs. The main goal of the Platform is to contribute to a dynamic knowledge-based economy, in line with the ambitious Lisbon agenda set by the European Union. In this regard the Platform primarily focuses on the development of scientific and technological talent – the human capital that is worth its weight in gold.

Realising ambitions

Whether you work for an education or knowledge institute, in a sector or a business, everyone has ambitions. Your business may want a stronger science and technology recruitment policy. Your school may have plans to integrate subjects or introduce continuing learning tracks; a university may be expanding its bachelor's programme. Ambitions are the first step, but putting the plans into practice comes next. By joining the Platform's innovative programmes, organisations can make their ambitions a reality.

Joining a growing network developed by the Platform

Thanks to the delta Plan Science and Technology the science and technology movement is gaining in strength and speed. There were at the end of 2006 some 1330 primary schools, over 150 secondary schools, almost 175 VMBO schools, 10 regional training centres,18 polytechnics and 10 universities that are working with the Science and Technology Platform on high-quality education. Challenging science and technology education that offers opportunities for top talent, while giving people with less training the chance to join a modernised knowledge-based and service economy. The same applies to an increasing number of businesses, sectors and regions that are working with the Platform to develop potential and a career policy for scientists and technical experts. The growth of the science and technology movement offers opportunities. It is a good time to join in, and for those already involved to take advantage of the growing network and the opportunities to learn from each other's approach. The knowledge and expertise available in the fields of innovation, science and technology continue to grow.

Personal responsibility, at one's own pace

In the Platform programmes, institutes, sectors and businesses take responsibility for innovation. Organisations decide for themselves how they innovate and set their own pace. The Platform plays a role as an initiator and provides innovative solutions. Active support is offered in the form of advice, feedback and practical assistance. Everything is geared to realizing the ambitions of the participating organisations. The partnership is formalised in clear performance and innovation agreements between the platform and the participating institutions.

Profiting from knowledge base and expertise

Organisations that choose science and technology can count on inspired services from the Science and Technology Platform, which is the linchpin of expertise in the field of science, technology and innovation. The Platform offers additional financial resources, but primarily focuses on advice, monitoring and auditing, expert meetings, focus groups and knowledge exchange. This allows businesses and institutes to profit from the knowledge network and know-how of the Science and Technology Platform. Practical solutions and in-depth research yield the insights needed to apply solutions in other contexts as well. This knowledge base only continues to grow.

Feedback as a mirror

One important part of the partnership is monitoring and auditing. Experts from the Platform regularly discuss the actual situation with the participating schools and businesses. This feedback allows them to show everyone a mirror of their work. Institutes and businesses gain insight into how effective their measures are.

The right connections

The Science and Technology Platform makes agreements at the level of the school, institute or sector, and also tries to create favourable preconditions at national and regional levels. The Platform makes the right connections, e.g. by forging alliances of politicians, employer organisations and the education sector. The approach is also in line with the policy lines in the Industry Letter (Industriebrief), the Memorandum on Peaks in the Delta (Nota Pieken in de Delta, (Ministry of Economic Affairs), the Direction for Primary and Secondary Education (Koers Primair en Voortgezet Onderwijs), restructuring of MBO senior secondary vocational education and the science and technology sector plans for HBO higher professional education and university education.

The Platform also signed covenants with industrial areas such as Eindhoven, Limburg and Twente. There is close cooperation with well functioning regional networks such as the Techno-centres, the ITSO cities and Syntens. Arrangements with sectors will provide form and content in the coming years for the broad science and technology ambitions.

Knowledge development

Successful innovation is closely connected to the way in which organisations gain, apply and share new knowledge. To promote knowledge development, the Platform worked with the ROA Research Centre for Education and the Labour Market to set up a research programme. Newsletters, an annual essay collection entitled Technotopics and the biannual Technomonitor offer access to trends, developments and data in the field of education and the labour market. The Platform also supports action-driven research and is involved in exploring the state of science and technology in various fields and sectors.

Sharing knowledge

Innovation demands open source networks where knowledge is shared. Each Platform programme therefore ensures accessible infrastructure. Such formats as online knowledge banks, multimedia presentations, expert meetings and master classes ensure that everyone in the science and technology movement can share experiences, via a low-threshold point of access.

Choosing a long-term approach

The Platform works with organisations whose goals and plans are embedded in their organisational policy, so that innovation continues even after the temporary incentives end. To facilitate this, the Platform has developed a **compass**, setting out guidelines for realising the science and technology ambitions. The guidelines are based in part on successful experiences the organizations have had.

The compass is composed of 6 key elements as parts of institutional policy:

- Image and representation
- New methods (new didactics/ reorganize work)
- Chain approach
- HRM-policy
- Professional orientation & career development
- Innovation (contents, products & processes)

Setting a course by a tried-and-tested compass

Businesses and institutes can use the guidelines to draw up their policy. They determine for themselves whether they want to use all the elements of the compass as an integrated whole or only certain elements. Organisations can also work in stages, starting with a few elements – such as HRM policy, new forms of working, career orientation – and later embracing others, such as a chain approach, image and conceptualisation. The more compass elements schools and businesses integrate into their organisational policy, the greater their chance of successful innovation and of strengthening the position of science and technology.

Good organisation, clearly defined programmes

To give the science and technology movement the power and drive it needs, focus is required. A good organisation and clearly defined goals make it possible to actually realise innovative ideas. Based on expertise acquired and concrete experiences from the world of science and technology, the Platform has developed programmes throughout the chain. Tailored to various sectors of education and the labour market, these programmes give schools, institutes and sectors the opportunity to take control of implementing their ambitions in the field of science, technology and innovation.

Different images, different choices

Besides this sector-and programme-based approach, the Platform also aims to increase awareness and improve image. Working with players from the education sector and the labour market, the Platform is seeking to change the way people see science and technology – for example by showing young people different worlds in science and technology, different images that can change their minds. The 'worlds of science and technology' fit in with young people's motivations and the innovations in education. These worlds also offer businesses and institutes openings for communicating effectively with young people. Direct connections that create a dialogue involving young people, students and professionals are important in that context. The Platform is accordingly closely involved in the Youth and Technology Network Netherlands (Jet-Net), which creates direct contacts between pupils and researchers from the business sector. The Platform also supports what are known as one-on-one networks between students and pupils in the "science 1on1" ("beta 1op1") programme, in cooperation with the higher education sector.

Long-term objectives of the Delta Plan

Objective: more employees that make a contribution to innovation.
Indicators:
1. More attractive, more differentiated and more popular education in science and technology throughout the sector, manifesting itself in a lower dropout rate and more graduates from the vocational sector and S&T university study programmes;
2. More attractive career prospects for knowledge workers and, especially, among scientists, engineers and researchers on the labour market.

Medium-long term objectives:

Objective: 15% more graduates from the higher S&T study programmes in 2010 than in 2003.

Greater balance between the intake of men and women. Better international recruitment position for scientists and engineers.

Interim objectives for 2007

1. 15% higher intake for 2007;
2. Higher intake of women and ethnic minorities;
3. More foreign students and knowledge workers.

The Platform Bèta Techniek (Science and Technology)

The implementation of the Delta Plan Bèta Techniek is the responsibility of the Platform Bèta Techniek. The Platform was commissioned by the government, education and business sectors to ensure sufficient availability of people who have a background in scientific or technical education. The aim: to achieve a structural increase of 15 per cent more pupils and students in scientific and technical education and to use existing talent more effectively in businesses and research institutes. The aim is not just to make careers in science more appealing, but also to introduce educational innovations that inspire and challenge young people. The Platform therefore targets schools, universities, businesses, ministries, municipalities, regions and sectors. The objective is to ensure that the future supply of knowledge workers will meet the future demand.

It is not simply about 15% more beta technicians. It is about working to create talent for the future: more beta technicians who have broader competencies, and increased affinity with science and technology in the entire population. It is also about more effective deployment of the talented professionals already in the job market. Particular attention is paid to women and ethnic minorities. A broad approach is needed. The approach is divided into the 5 sub-programmes outlined below. Full information is to be found on: http://www.deltapunt.nl/

Sub programmes of the Delta Plan Bèta Techniek (Science & Technology)

The following sub programmes of the Delta Plan Science and Technology were presented to the PLA participants:

- **VTB: Verbreding Techniek Basisonderwijs (Enlargement Technology Primary school)**
- **Universum (supporting schools with a science profile in general secondary education, HAVO and VWO)**
- **Ambitie or Ambition (supporting lower and upper secondary vocational schools: VMBO and MBO)**
- **Sprint (More students in science in polytechnics HBO and universities**
- **Act (Promoting appealing careers in technology)**

For those interested details about the 5 sub programmes are added as annex 2 to the present deliverable.

Annex I: NTA

NTA, Naturvetenskap och Teknik för Alla or Science and Technology for All, Sweden

The objective of Science and Technology for All, - NTA- (Naturvetenskap och Teknik för Alla) as a school development project, is aimed at stimulating students' and teachers' curiosity about, and increasing their interest in, science and technology. The project is primarily intended for classes from kindergarten through 6th grade. The project is being run jointly by the Royal Swedish Academy of Science (KVA) » and the Royal Swedish Academy of Engineering Science (IVA) » in cooperation with municipalities throughout Sweden.

NTA support children's and young people's learning in biology, physics, chemistry and technology, and also provides indirect support in other subjects. The basic philosophy underlying NTA is an inquiry-based work method that puts students and their interests and curiosity in focus. Students carry out experiments and practical investigations in which they use their previous experiences and knowledge. In NTA, great emphasis is placed on students expressing - both orally and in writing - their understanding and knowledge of various phenomena in collaboration with each other and with adults.

NTA offers many different thematic areas - NTA units - within biology, physics, chemistry and technology, all of which are founded on a inquiry-based work method. Every NTA unit consists of a complete set of experimental material and written instructions for work with an entire class for 10 to 12 weeks. Prior to each thematic period, participation teachers receive a complete set of experimental material and instructions, that is, everything they need to carry out the unit. The material for each unit suffices for about 30 students, and experiments can be carried out in the classroom without special laboratory equipment. When the unit has been completed, the material is collected and then supplemented at special material support centres. At this point, refurbished set can be delivered to a new class. Thus teachers are freed from the job of searched for appropriate material, and can instead concentrate on teaching.

Every teacher using a unit completes one day of training in that thematic area. Teachers are also given repeated opportunities to share their experiences surrounding issues of learning and teaching. In this way, NTA serves as a support for the teaching teams' professional development in physics, biology, chemistry, technology, pedagogy and curriculum science. Professional development is carried out in collaboration with experienced teachers, industry, colleges and universities. NTA helps teachers and students to continuously evaluate what the students are learning and how they are developing. NTA also undergoes continuous development based on teachers' and students' experiences with the project. The teacher teams play an active role as testers/developers of working methods and subject content.

A coordination group organizes collaboration between the schools and other actors in the municipality, for example, local industry and higher education. The basic idea underlying this cooperation is proximity. A platform for exchange is created that transcends traditional boundaries. One example is Retirees at School, a program in which retired scientists and technicians become involved in the school, supporting teachers in their planning and teaching. NTA's contribution is a model of school development work that can be applied to several subject areas.

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Website : http://www.nta.kva.se

Annex J: CHIK

CHIk, Chemie im Kontext (Germany)

The goal of ChiK is the development, evaluation and implementation of an innovative chemistry course for students between the ages of 14 and 18 (lower and upper secondary level), which combines the principles of situated learning with a systematic understanding of the most important concepts of chemistry. It will provide teachers and students with a documented and partly evaluated course and its own assessment procedures. ChiK confronts the well-rehearsed problems of science education in Germany, namely· students interest in chemistry declines as they progress through the school;· students find the concepts difficult to master;· uninspiring teaching using out-of-date curricula.

The lessons in ChiK are based on three principles:1. An implementation of the principles of situated learning: The course is based on authentic contexts which are relevant and interesting for the student, such as The hydrogen car for the future? or Polymers - boom or waste?.2. Development of basic chemical concepts: Skills and competencies are interwoven into a few central concepts, such as matter and particles, structure and properties, energy and entropy.3. A methodical implementation of the principles of situated learning:

In order to give students the opportunity of reflective learning and the time to master the basic concepts, the lessons are arranged in a cycle of four phases:

(i) a phase of contact, when the context is presented and the students articulate their knowledge and ideas on the topic;
(ii) a phase of curiosity, when students develop strategies to explore the topic and plan further work;
(iii) a phase of elaboration, when the work is carried out, chemical principles are being developed and the results are presented to, and discussed with, other students;
(iv) a phase of deepening and connecting, when the context of the work is linked to other contexts and to other chemical principles. This cycle is characterized by the use of many different teaching and learning strategies.

ChiK brings together in **partnerships and networks** a very wide range of groups and individuals, each with their own expertise. These include teachers, scientists and science educators (from science education and the social sciences). All are playing an important role in the construction, evaluation and implementation of the course. SINUS, Chik and PiKO – Improving teaching of maths and the sciences. The Federal government and the Länder have launched a transfer programme to bring the results of the SINUS Programme for increasing the efficiency of teaching mathematics and the sciences into all schools nation-wide in Germany. Furthermore, the BMBF (Federal Ministry of Education and Research of Germany) supports other projects to improve science classes at school.

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Website : http://www.ipn.uni-kiel.de/abt_chemie/ChiK/index.htm

A similar initiative exists for Physics which is called PIKO.
Website : http://www.uni-kiel.de/piko/kontakt_en.php

Annex K: ECOschools

ECOschools in Cyprus (and elsewhere)

From http://www.eco-schools.org

The Eco-Schools Programme aims to raise students' awareness of environmental and related sustainable development issues through classroom study together with school and community action, and provides an integrated system for environmental management of schools based on an ISO14001/EMAS approach. During the classroom activities specific focus is given to sciences and their role in relation with environmental education. In this way sciences are linked up with a concrete real life issue which appeals to children. The ECO schools programme thus raises interest and motivation for science learning and teaching.

Eco-Schools is a programme for environmental management and certification, and sustainable development education, for schools. Its holistic, participatory approach and combination of learning and action make it an ideal way for schools to embark on a meaningful path to improving the environments of schools and their local communities, and of influencing the lives of young people, school staff, families, local authorities, NGOs, etc.

The Eco-Schools programme was developed in 1994 on the basis of the need for involving young people in finding solutions to environmental and sustainable development challenges at the local level, as identified at the UN Conference on Environment and Development of 1992.The programme was initiated by Member organisations of the Foundation for Environmental Education with the support of the European Commission. As a process of facilitating sustainable development at a local level, pupils are encouraged to take an active role in practical steps to reduce the environmental impact of the school. Eco-Schools thus extends learning beyond the classroom and develops responsible attitudes and commitment both at home and in the wider community.

The Eco-Schools Green Flag, awarded to schools with high achievement in their Programme, is a recognised and respected eco-label for environmental education and performance The Programme incorporates seven elements which schools at any level can adopt as a methodology. These elements have been designed to be the core of the Eco-Schools process, yet the structure is flexible enough to be adopted in any country, and at any level of schools' previous environmental achievement. Pupil involvement throughout the process is an integral and essential factor. The participation of other stakeholders in the school and community in the decision-making process is an important step towards dialogue and cooperation, providing a good basis for citizenship education.

This flexible system, with its pedagogic and practical elements, has made Eco-Schools a very successful programme with clear and tangible benefits to schools and communities, and of course to teachers and young people. The programme is now being implemented in several countries in Europe, Africa, South America, Oceania and Asia. The number of Eco-Schools is growing as more and more schools take up the challenge and work towards improving their environment through education and action. Newsletters, email news and the online projects keep schools in touch and aware of developments throughout the network, and periodic international events are organised for personal and direct contact.

Eco-Schools programme may be known by different names in different countries, though they share the same methodology and concept, and are identified by the Eco-Schools logo and Green Flag. A number of activities, events and materials are available to support young people in their work, and training for teachers and others, both at the national level for country and region-specific support, and at the international level. National programmes count on Partnerships with Institutes, Organisations, Public Entities and Corporate sponsors to provide appropriate support to participating schools