EUROPEAN COMMISSION
Directorate-General for Education and Culture

Lifelong Learning: horizontal Lisbon policy issues and international affairs
**Lifelong learning: innovation and creativity**

**EDUCATION AND TRAINING 2010**
**WORK PROGRAMME**

# Cluster 'Mathematics, Science & Technology' (MST)

# COMPENDIUM
# of
# GOOD PRACTICES in MST

**Peer Leaning Activities (PLA) in**

**FRANCE, THE NETHERLANDS, NORWAY and SWEDEN**

**2006, 2007 and 2008**

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Updated: 30/06/2008

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## 1. INTRODUCTION : THE MST CLUSTER AND THE PLA OR PEER LEARNING ACTIVITY

### The Cluster and its priorities

Peer Learning is a central element of the 'open method of coordination' in education and training and, as confirmed by the discussions in the Education Council, is seen as a crucial tool with considerable potential to support education and training reforms. The second phase of the Education and Training 2010 work programme involves different activities using various working methods depending on the nature of the thematic priority being addressed. The aim is to ensure a flexible approach that takes fully into account the specific needs of countries and of thematic priorities in terms of policy development and implementation.

On the one hand, Peer Learning Activities (PLAs) have been developed since 2005 by clusters of countries sharing common interest in a thematic priority. Their aim is to bring policy implementation closer to national needs and situations. On the other hand, activities planned also include other methods of work: seminars, conferences, thematic and expert networks, studies and research, expert groups, support from Cedefop, ETF and Eurydice.

In that context, the Commission has set up a cluster on the specific thematic: **"Maths, Sciences and Technology"**. The word "cluster" is used to mean the grouping of interested countries around a specific theme, corresponding to their national policy priorities and key areas of the E&T 2010 work programme, and on which they have expressed a desire to learn from other interested countries, or to share with others their successful or unsuccessful experiences.

The MST Cluster is composed of **13 countries (CY, DE, DK, FR, IS, LV, MT, NL, NO, PT, SE, SK and UK).** The MST Cluster has been set up to follow the European MST benchmark and to improve participation in MST studies and careers, especially regarding women (E&T 2010). It also contributes to prepare scientific specialists for the Barcelona objective of reaching 3% of GDP in research. Moreover MST is one of the eight key competences for Lifelong Learning.

**The priorities of the MST cluster are**:

Modernizing pedagogical methods;
Enhancing the professional profile of teachers;
Ensure transitions from secondary to tertiary;
Promoting partnerships between schools, universities and industry;
Addressing the needs of special groups;
Improve female participation in MST studies and careers.

### Examples of good practice

The present text brings together examples of good practice that participants experienced to the four PLAs organised so far in the area of Maths, Science and technology:

- The first PLA was held in the Netherlands from 13 to 17 November 2006 focusing on the Dutch Delta Plan Science and technology.
- The second PLA was held in Sweden from 21 to 24 May 2007 focusing on maths education.
- The third PLA was held in France from 8 to 12 October 2007 focusing on renovation in science teaching in France: an inquiry-based science education approach.
- The fourth PLA was held in Norway from 14 to 17 April 2008 focusing on Increased recruitment and better quality instruction in MST. A joint promotion of MST in Norway.

**Contents of the compendium**

The examples of good practices presented in this compendium are extracted from the initiatives experienced during the Peer Learning Activities organised by the host countries in cooperation with DG EAC. Thematic areas and programme were designed according to the priorities defined by the MST Cluster. The list of examples will be completed and updated with the upcoming PLAs.

- PLA in the Netherlands - November 2006
  The Delta Plan Science and Technology / Delta Plan Bèta Techniek

- PLA in Sweden - May 2007
  Action Plan for the Promotion of Mathematics Education

- PLA in France - October 2007
  Renovation in Science Teaching: An Inquiry-based Approach

- PLA in Norway - April 2008
  A joint promotion of Maths, Science and Technology

The Compendium can best be used in conjunction with the full reports of the PLAs to be found on the website of DG EAC: http://ec.europa.eu/education/policies/2010/objectives_en.html#math

## 2. MAJOR NATIONAL INITIATIVES OR ACTION PLANS

### 2.1. The Delta Plan Science and Technology in the Netherlands (NL)

The Delta Plan is a major plan to promote science and technology education launched by the Dutch Ministry of Education and Science in 2004.
The long-term objectives are to have more employees that make a contribution to innovation. This should lead to 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. It should also lead to more attractive career prospects for knowledge workers and, especially, among scientists, engineers and researchers on the labour market.

In concrete there should thus be 15% more graduates from the higher S&T study programmes in 2010 than there were in 2003, greater balance between the intake of men and women, higher intake of women and ethnic minorities, more foreign students and knowledge workers and better international recruitment position for scientists and engineers.

The implementation of the Delta Plan Bèta Techniek[1] 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 Platform 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.

The Delta Plan Science and Technology is divided into the 5 subprogrammes outlined below. Each of those programmes are briefly highlighted in the present text:

- VTB: Verbreding Techniek Basisonderwijs (Enlargment Technology Primary Education)
- 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)

Full information on the Delta plan Science and Technology is to be found on:
http://www.deltapunt.nl/:

### 2.2. The Swedish action plan for the promotion of mathematics education (SE)

A Delegation was set up in the spring 2003 to analyse the situation and to come up with a action plan with concrete proposals to increase the interest in and motivation for maths education across Sweden. The action plan developed subsequently contains four proposals to enhance the quality of maths education in Sweden. The action plan took on board successful initiatives that existed before the Delegation's report and the action Plan were drafted. The action plan also took stock of successful initiative implemented successfully before the Delegation drafted its report.
The four key proposals suggested of the action plan are outlined below.

1 Bèta means 'science'!

Support and develop activities to increase interest in and provide greater insight into the value, role and significance of maths in everyday and working life, in science and society:

- More focus on maths by the science centres (see visit of the NAVET Science Centre)
- Developing the Kangaroo competition further as to contribute to make maths more fun for children (see information about the Kangaroo competition)
- Increase interest in maths through various initiatives such as the INTIZE mentoring activities of engineering students of Chalmers University of Technology (cf Intize initiative)
- Focus on how to use maths concretely
- Information about maths for parents with flyers in childcare centres
- A brochure focusing on cooperation school and companies to strengthen the interest and motivation for maths (cf initiative of the European Round table of Industrialists ERI on maths)
- More research on this topic

Train qualified teachers in maths on all levels for all children, young people and adults.

- Attract more teachers to become maths teachers
- Improve initial teacher education
- More in-service teacher training through various pathways such as going back to university for one semester or organise school-based in-service training with teams of teacher (cf the Learning study method).
- More research on the topic.

Support teachers and coordinate all the positive forces promoting better maths education:

- Spread information about innovative maths teaching and learning through website, blogs, examples of good practice (cf. Nämnarem, Kollegieblocket)
- Create a network of maths teachers and create a link between teachers in schools and university (cf. Mattebron)
- Organise maths conferences: the biennials and the regional biennettes
- The organisation and development of the municipal network of math developers or ambassadors.
- More research on this topic.

Clarify aims, goals, content, assessment

- Enhance clarification of national documents as to aims, goals, contents and assessment
- Discuss in depth with teachers new aims and objectives of maths education
- Look into different (creative) ways to assess maths
- More research on those elements especially on the assessment.

Subsequent to the Maths Delegation and its report, the Swedish Ministry of Education and Research and the Swedish National Agency for School Improvement commissioned the NCM or National Centre for Mathematics Education to see to the implementation of the four proposals.

### 2.3. Renovation in Science-Teaching: An Inquiry-based approach (FR)

This initiative focusing around the Main à la Pâte initiative or Hands on science approach, originates from a visit of members of the Academy of sciences (Pierre Léna, Yves Quéré and George Charpak) (1992 Nobel Prize) to a Chicago ghetto. La main à la Pâte began in France in 1996 supported by the French Academy of sciences and by the Ministry of Education.
Ten years later, this initiative has become a key innovative mechanism in France. It is very well structured and is the basis for the reform of science education in the primary schools and in the collèges (lower secondary schools). It gives a strong logistical and pedagogical support to the teams of teachers and schools.

Key content elements for La Main à la Pâte

- 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
- overcoming social barriers., promoting social cohesion and inclusion
- science linked to developments in society
- the development of open-source contents

Key elements 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 a.o. 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

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), teaching specialists in science and other subjects, scientists, researchers, engineers, students from science universities or from the national colleges (Grandes Écoles), 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. It has an Internet site which provides opportunity for exchanges and dialogue between scientists and teachers and makes available numerous helpful resources.

For full information see the La Main à la Pâte website:
http://www.lamap.fr

**The PRESTE reform in France (FR)**

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 Prize**,** 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.

Key elements of this approach are:

- 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 time tables and programme of the primary school were defined by law on 25 January 2002[2]. 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 been mobilised and numerous partnerships have

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

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.
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.
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)[3] and at the level of the Départements.

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.

The full text of the PRESTE plan for renovation in science teaching and learning is available in French on the following website: http://www.education.gouv.fr/bo/2000/23/ensel.htm
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). http://www.cndp.fr/ecole/programmes/accueil.htm

**EIST, Enseignement Intégré de Science et de Technologie au Collège (FR)**

The 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: http://www.academie-sciences.fr/enseignement/guide_06.pdf
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[4] (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.

3 Académie= a 'pedagogical ' region in France; an administrative unit in The French education system. Not to be confused with an Academy
4 This is the first of four years of lower secondary education. Fifth class is the second year

The Aims of EIST are:

- 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).

This experiment is based on:

- 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;
- 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 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.

### 2.4. The MST Strategy: "A Joint Promotion of MST" in Norway 2006-2009[5]

In order to provide the Norwegian society and the individual with the necessary MST competence in the coming years, the main challenges are to:

- encourage young people, and especially girls, to choose study in MST in upper secondary education and to make career choices related to MST;
- strengthen MST in teacher training and raise the MST qualifications of teachers;
- improve the quality of MST teaching developing and spreading good practices;
- increase the cooperation between education and working life in order to create a greater sense of relevance and to encourage recruitment.

The strategy's overall goals:

- improve the MST competence in the whole educational system, in working life and in the general public;
- increase the recruitment to working life and education in MST;
- instil positive attitudes to MST among everyone in the educational system and among the general public.

The strategy has five key goals:

Goal A: Strengthen MST in kindergartens and primary and secondary education
Goal B: Improve teachers' qualifications and teacher training
Goal C: Development of MST in higher education and research
Goal D: Provide Norwegian working life with the MST competence that is needed
Goal E: Increase the MST competence and improve communication to the general public

Each of those goals are translated into several sub-goals. For each of the five goals and sub goals **indicators** have been developed to see whether the goals are achieved!
In the long term it is necessary to improve the situation regarding MST in the primary and secondary education. This requires measures to increase the teachers' competence in both subjects and methods. The key here is teacher training, continuing education and training, and subject-didactic research and practices.
In the short and intermediate term it is necessary to strengthen recruitment, to make career opportunities more apparent, and to strengthen contact between education and working life must be strengthened. The media also have to play an important role to support this process.

5 The full text of "A joint promotion of mathematics, science and Technology (MST)" is available on the following website :http://www.regjeringen.no/upload/KD/Vedlegg/Grunnskole/Strategiplaner/Strategiplan_for%20_realfag_engelsk.pdf

## 3. INITIATIVES BY LEVEL OF EDUCATION AND BY SPECIFIC TOPICS

### 3.1. Pre-primary school

**Pilot project in pre-school maths (1-5 years old) in Sweden**

The Swedish National centre for maths Education is involved in an innovative pilot project to promote maths in pre-school as pre-school should try to ensure that children develop the ability to discover and use mathematics in meaningful contexts and situations, develop their appreciation of the basic characteristics of the concepts of number, measurement and form, as well as the ability to orient oneself in time and space. Basic assumption for such a pilot project is that the pedagogical activities should be related to the needs of all children in the pre-school, where care, nurturing and learning together form a coherent whole.

The project is based on interaction adults and children, on what children learnt from each other, on exploration, the desire to learn – through play, social interaction, exploration and creativity, observation, discussion and reflection, based on children's and teacher's experiences and interest.
The specific goals of the project are to observe children's mathematics, to offer and stimulate experiences, reflections on development of early mathematics, to develop competences in studying, analysing, communicating and challenging children's abilities, to show the excitement and creativity of mathematics, to highlight the importance of playing and variation in children's thinking and learning, to support teachers' networks after the project.
The project focused on very concrete approaches of maths such as finding expressions and ideas of maths in nature, in cultural heritage and in everyday situations. By working in this way maths education is very often combined with other areas such as cultural heritage education.

The first part of the project was the organisation of several seminars for teachers: May 2003, half a day – NCM supervisors visiting preschools, Aug 2003, one day and a half – project presentation and discussion, Oct-Nov 2003, half a day twice – Number and Spatial sense and Feb-May 2004, half a day three times – Sorting, graphs, real world situations, play, evaluation, Children's literature.
In between these seminars the teachers met for half a day. They tried different activities with the children, made interviews, wrote a logbook, which formed the basis for the meetings. The pre-school managers were involved and participated in at least two meetings.

The project has resulted in very interesting pedagogical material to promote maths in the pre-primary school which will be disseminated largely and a number of national conferences where the NCM-team had seminars with about 3000 pre-school teachers altogether.

### 3.2. Primary Education

**VTB (Verbreding Techniek Basisonderwijs) (NL) Start young for later**

The objective is to link in the primary school exploratory learning and technology with the fields of learning as a means of creating a modern, innovative and motivating learning environment for children. VTB, together with regional networks constitutes a major reform in primary education. There are already 1,330 primary schools working in the programme. Teacher training colleges are involved too. They translate the key technology aims into competences for future teachers. A total of 2,500 primary schools will be given an extra impulse with VTB up to 2010. The results of this pilot will then be valorized towards all primary schools. The knowledge infrastructure will be strengthened by the establishment of a center of expertise, linking various databases and lecturers.

**The added value of VTB:**

- Extra energy and dynamism: schools can fulfill their own ambitions;
- Technology will become anchored in school policy;
- Schools can promote themselves in their surrounding areas;
- Expertise will be combined and promoted;
- Integrating subjects will become easier through broadening them within VTB;
- Schools will be supported regionally by a network made up of schools, businesses, technology centres, guidance services and science centres;
- Smoother tie-up between primary education and the first years of secondary education.

**The Nysgjerrigper project (Inquiry-based science teaching method), (NO)**

This is an initiative by the Research Council of Norway with the objective to enhance the interest of children for science and to improve the science teaching in primary and lower secondary schools. The initiative is largely based on the inquiry-based science teaching approach. It is compulsory to work with this kind of project in every primary school. The quality of the way in which the method is applied depends largely on the interest and the motivation of the teachers.

Nysgjerrigper offers a variety of science resources to stimulate children's curiosity, interest and imagination for science and technology. Experiments, articles and multimedia are, among other things, designed to enhance knowledge and awareness of research activities. There is a magazine, a website, a working manual for teachers, a science fair with prizes and an interactive manual on the website: http://www.nysgjerrigper.no/. There is also a teacher support group. Members of that team are experienced teacher that give in-service training to teachers in other schools to explain how they can work with the method.

The Nysgjerrigper Method is a method by which children are invited to come forward with scientific problem. All children suggest topics or issues to be looked at. The teacher makes a choice together with the children as to the tropics to be studied in the classroom. The topics looked at are all very close to the real life situation of the children.

Here are some examples of such topics which become scientific issues in the classroom:

- Why do pancakes have different pattern on each side when you bake them?
- Why do blood vessels look blue under your skin while the blood is red?
- Why is God always depicted as a man?
- Why does only one egg break when you smash two eggs against each other?

The Nysgjerrigper project works in 6 steps: children wonder why something is happening in a certain way, then they try to answer the question why is it like this?, they draw up a plan for the work in small teams, they collect data, they compare and discuss what they have found out and they report to each other. Thus children are invited to find such a topic which raises questions. They then decide on an approach to solve the problem and formulate hypotheses. They subdivide the task and in subgroups try to solve the problem by looking for answers. The answers are checked and verified scientifically. The whole process is documented on paper and ends with a report and other products.

The whole process is evaluated. It is usually spread over 2 to 3 weeks 3 hours a week during the school year.

**La main à la Pâte (FR)**

(Information above !)

### 3.3. Secondary schools

**The UNIVERSUM programme: Better off with science (NL)**

Schools are invited to create for themselves a specific profile in science education. 10O pioneer schools are involved at the moment. Monitoring, auditing and meetings allow schools to share experiences, proven concepts and good practices with each other, thus working together to build national innovation. Each Universum school can link up with a partner school, which it supervises and which may develop into a such a school school.

**The added value of Universum:**

- Schools can create a distinct profile for themselves in science;
- Strong appeal for pupils, parents and (future) teachers;
- Schools take a structured approach to improving quality based on a compass that education institutes developed themselves;
- Access to an active network for advice, expertise, feedback and practical assistance;
- Taking a leading role with new developments in the science subjects and in
- developing the new science subject: Nature, Life and Technology;
- Connections to a network of universities, polytechnics, knowledge institutes and businesses;
- The Universum school is close to social developments, which facilitates a smoother transition to higher education;
- Close cooperation with Jet-Net, the network that brings young people and businesses together.

**The AMBITION programme: Backbone of the knowledge-based economy (NL)**

The Ambition programme at VMBO (Lower VET schools) level try to bring the education programmes of VET schools and regional technology centres more into line with young people 's preferences and the demands of the labour market. Pioneer schools show that relevant, appealing education inspires more young people to choose technical studies and to progress to continuing education and work. Through shared knowledge and experience, the Ambition Programme invites schools to innovate and achieve excellent performance across the full scope of technology. Forty schools can sign up each year. An interactive process of monitoring young people, teachers and school management makes it clear which innovations have an impact. In the VMBO programme, the Science and Technology Platform works with the Techno-centres, Schoolmanagers and Platforms representing VET.

The Ambition Programme for MBO (upper secondary vocational schools) has started in 2007 with 7 schools. More than 20 schools will ultimately be able to participate. They make that choice based on the ambition of making intermediate VET education as appealing as possible to all those involved. Attractive, relevant VET education brings on more students, while improving progress and graduation into the labour market.

**The added value of Ambition:**

- Schools profit from the latest insights in student enrolment, professional fields and teaching;
- They share knowledge with their institutions to introduce innovations that lead o greater achievements;
- Receive support from the Platform in realizing their ambitions.

### 3.4. Higher Education

**Attracting more students in maths education in higher education (SE)**

Enhancing the interest for maths education especially in higher education has to do with working on the transition from the upper secondary school to higher education. A project focusing on transition from the upper secondary school to higher education originated from the fact that attention was raised on this issue through several reports. These reports showed that students failed in maths for a variety of reasons, there was a content gap, a culture gap, there was weak knowledge of algebra and arithmetic, the admission requirements had been lowered and there was limited cooperation between secondary schools and higher education to prepare the transition between the two.
Hence it was decided to start two projects to work on the transition from secondary to higher education. The first project is a three year project involving 29 universities. The second project is a one-year project involving 22 upper secondary schools.

Within the 3-year project the Göteborg University, in collaboration with the NCM, was given the assignment to develop an internet-based transition course (www.math.se), to organise national meetings to bring together key people concerned by transition issues and to stimulate local meetings also between all those concerned by the transition problems. This concerned mainly teachers from upper secondary schools, students in their final year of upper secondary school and lecturers from universities or university colleges. The internet-based course (www.mattebron.se). has been very successful so far as 4000 to 5000 students have already taken this course.

These two initiatives may be complemented by other activities such as: secondary school teachers giving maths courses in the first year of the university or university college, university lecturers going to schools are experienced university students mentoring or tutoring secondary schools students as in the Swedish INTIZE project. Closer cooperation between universities and secondary schools should also see to it that university professors are informed about the changes in the maths curriculum at secondary school level. Gradually universities have realised that the problems with maths are not mainly due to the pupils but are due to the teaching at the university and to the lack of cooperation between the university and the secondary school. Similar work will be done at the lower levels of the education system such as the transition from lower secondary to higher secondary schools.

### 3.5. Cooperation across different levels of education

**The SPRINT programme: Science and technology at top speed (NL)**

The key objective is to cherish science and technology talent. Scientific knowledge and skills are wanted on the labour market and offer students important assets for their future.
Education has to respond better to this need. More variation in the width and depth, close-knit networks with secondary schools and vocational training, close cooperation between higher education and academic institutions are developed. Sprint also encourages good cooperation with businesses, research institutes and alumni networks.

**The added value of Sprint:**

- Sprint links in with the internal ambitions and innovation policies of polytechnics and universities;
- Active support with the network in the form of advice, expertise, feedback and various forms of practical assistance;
- Access to networks of ambitious science schools and pupils;
- Extra attention to student enrolment, progress and graduation;
- Support in realizing continuing learning tracks and in educational innovation to offer students more variation;
- Better supply of future researchers at universities;
- Broader options for strengthening ties to businesses;
- Option of developing educational programmes offering interesting content,
- which combine quality with appeal;
- Educational institutions gain a clear picture of the progress of their educational innovation. Sprint is a learning programme.

### 3.6. Qualified teachers

**The learning study: professional development of maths teachers in Sweden**

The learning study is **a school-based in-service training for maths using** to contribute to professional development of teachers in a team approach within a school. . This is happening in cooperation with a university which is supervising and monitoring the initiative in its initial phase.

The ”Learning Study” is an arrangement inspired by the Japanese ”Lesson study” and by the idea of ”Design experiments”. The point of departure for a Learning study is a specific object of learning (i.e. something the students are supposed to learn). A group of teachers, usually together with a researcher, try to find as a powerful way of teaching the particular object of learning as possible. They do so by drawing on their experiences, earlier research, their mapping of the students’ pre-understandings and on a specific theory of learning. They plan and carry out a lesson (or a series of lessons) and try to find out how the students have appropriated the object of learning. Their observation of the lesson(s) and their analysis of the outcomes give them additional information to be used for revising the lesson plan. A new cycle of pre-test, lesson, post-test, evaluation is then carried out. The whole Learning study may comprise 3 or 4 such cycles. The participants learn from each other, from the students and from the theory. Again and again it is found that seemingly subtle differences in how the object of learning is dealt with during the lesson, yield dramatic differences in how it is appropriated by the students.

A learning study is a systematic attempt to achieve an educational objective and learn from that attempt. It is a design experiment that may or may not be a lesson study. Such a study is a learning study in two senses. First, it aims at bringing learning about, or more correctly, at making learning possible. The students will thus learn, hopefully. Second, those teachers involved try to learn from the literature, from each other, from the students, and not least, from the study itself.

The cycle of a learning study comprises the following steps:

1. Choosing and defining a specific set of educational objectives. These have to be capabilities or values to be developed during one or several lessons.
2. Finding out the extent to which the students have developed the capabilities or values targeted before the teaching begins.
3. Designing a lesson (or series of lessons) aimed at developing these capabilities or values. The planning work must take into account the existing knowledge of the students, the teachers' prior experiences in dealing with the objects of learning, and the research literature.
4. Teaching the lesson (or lessons) according to the plan.
5. Evaluating the lesson (or lessons) to see the extent to which the students have developed the targeted capabilities or values.
6. Documenting and disseminating the aim, procedures and results obtained.

For further information: : http://www.educ.umu.se/presentation/publikationer/lof/lofu_nr1_2007

### 3.7. Stimulating learning environments

#### The Inquiry-Based Science Education (IBSE) method

THE IBSE method is used in different countries in Europe. La Main à la Pâte in France is based on it and so is also the Nysgjerrigper (Curious Peter) project in Norway. Information is to be found elsewhere in this compendium about those two initiatives.

The inquiry-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, parents, inspectors and educational advisers, college of education training staff, teaching specialists in science and other subjects, scientists, researchers, engineers, students from science universities or from other institutions of higher education.

Difficulties in promoting and implementing the inquiry-based approach are:

- 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.

The Nysgjerrigper project also applies the IBST method. It works in 6 steps similar to the Main à La Pâte methodology:

- children wonder why something is happening in a certain way,
- then they try to answer the question why is it like this?,
- they draw up a plan for the work in small teams,
- they collect data,
- they compare and discuss what they have found out and
- they report to each other.

Thus children are invited to find a topic which raises questions. They then decide on an approach to solve the problem and formulate hypotheses. They subdivide the task and in subgroups try to solve the problem by looking for answers. The answers are checked and verified scientifically. The whole process is documented on paper and ends with a report and other products. The whole process is evaluated at the end. The project is usually spread over two to three weeks at an average of 3 hours a week during the school year.

The advantages of working with this method are the following ones: children learn to work together to solve a problem, the interest for science is raised, they acquire skills in research methodology e.g. by gathering and comparing data and they apply ICT and the use of the internet in their science work. The project also has an impact on children's attitudes towards science

**Hand-on maths / Matematikverkstad (SE)**

The objective of a mathematics workshop is to create an environment within the school where the learning and teaching of maths if facilitated. Usually such a hand-on workshop is a classroom that is arranged and furbished in such a way that everything which is around will invite learners to work with figures, shapes and symbols. Hands-on materials such as everyday objects and things, educational materials and games are all brought together in one room or placed are used by the teacher to stimulate the learning of maths. The materials can be used by the teachers in various ways: they can use them as a practical starting point before tackling some theory or vice versa. It depends upon the choice of the teacher.

Everyday objects may be things like buckets, decilitre measures, measuring-tapes, empty boxes, strings, clothes-pegs, bottle caps, dice, stones, leaves and so on. Ordinary everyday things can be brought into the math workshop and used to explore and explain all kinds of mathematical content. Educational materials, things that have been explicitly designed to help students to learn mathematics. E.g. multicubes, digi-blocks, Cuisenaire rods and geostrips. Games, both in society well-known games (monopoly, chess, mancala) and games explicitly designed to be used in math teaching (e.g. the algebra horse race).

A maths workshop helps teachers to plan and realize stimulating maths teaching. When they are planning a lesson they don't have to "run around" looking for things – such as hands on materials – they need, they don't need to bring anything from their own kitchens, they don't have to go shopping. Everything they need is to be found in the maths workshop.

It's a place where the teachers gather and share their knowledge. Teachers say they are very satisfied to know where to store hand on materials, activities, ideas and so on that they get in touch with on courses, from internet, in booklets etc.

Students say it's a place where you get curious, inspired and want to achieve a little bit more. Both teachers and students emphasize: It's funny! – to teach and to learn maths in the maths workshop. The most common is that the class spends one lesson every week in the maths workshop and the rest in the ordinary classroom.

The colleagues in charge of the hands-on maths workshop at NCM support the Swedish teachers with conferences and courses. Last year they ran two big conferences with about 600 teachers. Earlier courses were held for more than 350 teachers from over a hundred schools in Stockholm and now more are planned for the rest of Sweden. A book has been written on how to build, use and develop a maths workshop. A Norwegian version also exists! A Study circle was created on the NCM website that teachers can use when they want to read the book in a team and start to build a maths workshop. A project plan is available to help schools that want to create a mathematics workshop.

For further information: http://ncm.gu.se/mv

### 3.8. Involvement of / partnerships with companies

**The ACT Programme: Appealing careers, innovative businesses (NL)**

The ACT Programme helps employers to take a structural approach to availability and better deployment of scientists and technical experts. For example, science and technology action agendas have been drawn up for technical sectors and an inventory has been made of the 'human talent' dimension of the key innovation areas. The aim of this is to guarantee the ongoing availability of talent for the strong innovation clusters in the Netherlands. Integrated regional action plans are also being implemented in active innovative industrial core areas, such as in Eindhoven, Limburg and Twente. The Casimir programme shows that public-private mobility makes the job of researcher more appealing. It will be enlarged towards the future.

**The added value of ACT:**

- Reduce the shortage of science and technology staff;
- Businesses and institutions strengthen innovation and competitive capacity by;
- Systematically developing talent for their company;

- Benefit from pooled strengths in the network and resources of the Platform, Syntens[6], Techno-centres, regional and local governments;
- Employers benefit from the extensive network of ambitious science and
- technology-oriented educational institutions;
- Businesses and institutions benefit from each other 's knowledge and from successful, sometimes unorthodox concepts;
- Improve the image that younger generations have of the world of science and technology;
- Researchers gain valuable experiences that strengthen their career potential.

**Jet-Net (NL)**

Jet-Net was set up in 2002 between five major companies, the economics and educations ministries, Dutch employer's organizations and intermediary organizations in the education sector. Its prime aim is to stimulate increased interest among high school students to pursue their studies and future career in Science and Technology. Direct encounters with technical experts from the businesses give pupils a much better image of working in the technology sector, which allows them to choose a better course. Lesson modules, 'engineers for the classroom' career guidance and all sorts of excursions offer pupils a fresh new image of technology in businesses and its value to society.

**Facts and figures**

- Target increase of annual enrolment in higher science and technology education: 5000 students;
- 25 active (mainly large) industrial companies (with over 60 operating units or company locations) in all regions;
- An additional 180 individual engineers and technologists of a wide range of companies participate in school briefing sessions for students;
- 125 participating schools;
- 300 science and math teachers are involved on a regular basis;
- Average input: 25k / 35k euro per school/year;
- Effective outreach: 25.000 students per year participating in Jet-Net activities.

Special teams are assigned to assist the Jet-Net companies in quality development and in formatting the various types of program components, thus facilitating effective relations with the schools. Jet-Net makes a substantial contribution to the overall innovation of pre-university education.

Programs are established between individual schools and companies, ideally covering the entire school period. They are both geared to add practical context to the science curriculum but also to enlighten students on the broader career prospects in industry and technology.

Various activities are implemented:

- Jet-Net Excursions and guest lectures: as part of an initial orientation program companies assist schools in allowing students to develop a general understanding of industry and technology.

6 Syntens : an organisation supporting innovation at all levels of the Dutch economy !

- Jet-Net Workshops and projects : students are given group assignments in which they learn to present a report on specific themes, or to develop a solution to a specific technological problem.
- Jet-Net Individual assignments : company staff can assist individual students, e.g. in setting up their end of school thesis.
- Jet-Net Regional and national Events : Jet-Net Career Days and teachers event. During the former each year approx. 1500 students of Jet-Net schools aged 16-17 years are invited to participate in a major educational event offered by the Jet-Net companies. The latter are designed by Jet-Net companies to further enhance their joint programs and to provide teachers with a broad outlook on current trends in industry and technology and to allow the companies to better understand the needs of the schools.

For more information, see the website: http://www.jet-net.nl/start.html

### 3.9. Students as mentors or tutors of pupils or teachers to promote MST

**The students of the Stichting Techniekpromotie of the TU Delft (NL)**

Students of the Technical University of Delft are involved to promote science and technology with school children. They work half a day or one day with pupils in the secondary school on science topics such as building robots, building a small bridge etc. They contact the schools to see whether they are interested in having them. In 2006 they reached 40.000 children during 200.000 contact hours. Student get a student-assistantship contract for 4 hours a week during which they promote science and technology with pupils. The cost of one hour is less than 4 €. The activity is seen by the students as an important element of social entrepreneurship.

For further information: http://www.techniekpromotie.nl/

**The INTIZE initiative: Engineering students mentoring secondary school pupils (SE)**

Students from Chalmers University of Technology and Göteborg University offer pupils – especially in poor and disadvantaged neighbourhoods- the unique opportunity to receive free private tutoring lessons in mathematics from the beginning of the lower secondary school all the way through to upper secondary school. Every week, more than 250 upper secondary school pupils travel to Chalmers to meet their mentors. Every mentor is responsible for four upper secondary school pupils. Those pupils receive in their second year the opportunity to tutor the lower secondary pupils.

With the approval of the head of the school and the teachers, the students invite the pupils to come to the university during the weekend. They organise help and tuition and also sports activities. During soccer matches the pupils meet other players from companies such as engineers, marketeers etc. This creates an indirect opportunity to motivate young people for future work in a company.

Intize's mentors help break the myths about maths by convincingly explaining the purpose and the value of mathematics to the students, which enables the students to be more open to and involved in all of the opportunities that a strong mathematical foundation provides. In addition, the students become accustomed to and are welcomed in to the dynamic university environment, where positive role models and future prospects are ubiquitous.

On the one hand the university students mentor the upper secondary school pupils as to maths and on the other hand they train upper secondary school pupils to act as mentors towards lower secondary school pupils. Research has indeed shown that pupils can best be motivated by peers or

fellow pupils that are not too different in age. In this way the project also promotes active citizenship at different levels.

The university students commit themselves to be involved during their free time and they accept to be trained to do their job of mentoring efficiently. It is a bottom-up initiative totally driven and implemented by the university students. The university support the initiative morally and financially

The students act as natural role models and are accepted as such.

Effects on the pupils:

- It heightens their self-confidence in general;
- It strengthens their motivation for maths learning and makes them see better how maths can contribute to their personal and professional life;
- It broadens the horizons of the pupils concerned;
- It helps them make their choice of their future studies and of their future professional career; its is an important element in guidance;
- It changes the way in which they see maths;
- It makes them feel more included in the Swedish community at municipal level;
- It has an impact on their active citizenship.

Effects on the students, mentors:

- It increases their communication and intercultural skills;
- It strengthens the integration of their own knowledge and competence as to maths;
- It contributes to their feeling of active citizens.

Chalmers' University of Technology has developed an optional course of "Social or societal entrepreneurship" (of 5 ECTS credits) which a student can take as part of this normal curriculum.
For further information: http://www.intize.org/index_eng.php

**The MECHATRONICS project : engineering students helping Vet pupils (FR)**

The project is based on links between Ms. eng. students and VET pupils through industrial design projects. The first objective of the Mechatronics project is to ensure a better understanding of problems related to the design and implementation of technical systems involving a balanced combination of mechanics and electronics. For the first time in their education, students have an opportunity to learn through practical experience how to devise a system in accordance with functional specifications.

The Mécatronique /Mechatronics projects aim first at the modelling, the design and the manufacturing of complex systems, involving a balanced combination of mechanics and electronics. This tries to reproduce the development methods used in the car or air-plane / air manufacturing industry, where mechanics, computer science, electronics, design, and manufacturing are closely associated. Ten different subjects are offered, including the design of a flying drone, the design of autonomous robots (Coupe de France de Robotique "E=M6") or the design of a vehicle for the Marathon-Shell competition.

The second objective is to make students aware of problems related to working in teams, with different levels of skills, in long-term projects. Within the context of this course, students therefore

work in project groups in conditions that are similar to those to be found in industry. They have an opportunity to work closely with students studying for a BTS, Bac Pro and BEP in technical colleges which are partners of the École des Mines in the various phases of a project that extends throughout the second year. Thus, Ms. eng. students from Ecole des mines de Paris work together with BTS students from vocational schools (dedicated to mechanics, electronics or industrial computing) half a day per week through a whole year under the supervision of professors from each institutions. For the manufacturing phases, BTS students can involve in the project younger students from vocational high schools. Students and professors use a "PLM platform" (Product Lifecycle management platform) equipped with several softwares. In 2006-2007, the ten projects involved 117 Ms. Eng. students, 94 BTS students and around 20 professors from the Ecole des mines and from 10 vocational schools.

A substantial part of the work consists in gathering the information required for decision-making during the design phase. The results of some of this research are communicated to all of the students in that year. With that aim in mind, an “information manager” is appointed in each group.
From the beginning of the design phase, students from the BTS, BEP and Bac Pro departments of the partner technical colleges are involved for manufacturing the mechanical components of the projects. The École des Mines students must handle communication and the organization of work with these institutions in order to conduct the manufacturing phases satisfactorily.

The electronic, monitoring and industrial computer components of the projects are usually designed and manufactured on the spot, but partnerships can be envisaged, for certain projects, with the technical colleges which have an electronics department.
The design of the mechanical part is carried out with the Catia software. A collective working area and a project management software must also be used. Other types of software are made available to the students to respond to specific needs, particularly for electronics.
The students are required to present their work on the occasion of two vivas (at the end of the third and at the end of the fourth semesters). The results are assessed through the vivas but also through documents drafted and submitted by the students who must also include specifications, a design report and a maintenance manual.

Since 2003, this pedagogical experience showed very positive results in terms of:

- possibility for students to realize a complex system in industrial working conditions;
- comprehension of the human problems related to working in a team;
- mutual respect between students from different scientific cultures and professional skills;
- pedagogical enrichment for the professors of both institutions;
- enhancement of the self-confidence of the BTS students;
- motivation for the younger students in the vocational schools for undergraduate studies.

Information in French: http://graduateschool.paristech.org/cours.php?id=76980
In English: http://graduateschool.paristech.org/cours.php?id=76980&langue=EN

**Scientific coaching of teachers by engineering students (FR)**

Studies have shown that the teaching of science was not popular in the primary school in France. Only 3% of the primary school teachers were teaching explicitly sciences. This had to do with the fact that primary school teachers in France, before being trained as primary school teachers, get a bachelor or licence. When they have finished their bachelor's degree they apply to an IUFM, an Institut de Formation des Maîtres or Teacher Training Institution. Most of the bachelors (some 80%) that apply to become teachers have not studied exact sciences during their bachelor studies and during the two years at the IUFM there was a clear lack of time to upgrade their science teaching knowledge and skills. Hence many primary school teachers with a non scientific background feel very insecure when they have to teach sciences. Within the frame work of the Main à la Pâte initiative schools can ask for the support of engineering students to support the primary school teachers in the teaching of science. Thus a partnership is set up between the engineering school and the primary school. Lower secondary school may also benefit from this initiative.

Special attention is given within this initiative to the following elements:

- 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.

One project is "Accompagnement en Science et Technologie à l'Ecole Primaire (ASTEP)" or Support in science and technology at the primary school.

The Ecole des Mines de Nantes, a school of engineering, has been involved for the past 12 years in building an original partnership with local primary schools and educational institutions. This partnership aims at encouraging and facilitating inquiry-based science learning at primary and secondary school.

It consists of :

- primary school teachers' coaching by engineering students and professors,
- training workshops for primary school teachers,
- secondary teachers' coaching by PhD students.

The main goal is to get primary school teachers more self-confident in scientific teaching, after working in pairs during a few months, and to help secondary teachers carrying out experimental inquiries in their classroom.

The Ecole des Mines simultaneously developed since 1996 hands-on learning for its own students: learning by doing, problem-based and project-based learning ... all ways of teaching strongly impacted by Main à la Pâte (hands on Science) experiences.

According to the audience's wishes on Wednesday afternoon, the presentation will describe either organisation, rules and requirements, main data, advantages or outcomes of this partnership. These include new skills for engineering students and for the Ecole des Mines' educational methods.

The main conclusion is that both primary and secondary schools, on the one hand, and universities and engineering schools, on the other hand, could gain a lot if bridging a little the gap that naturally exists between them.

On 5 and 6 December 2007 a conference will be held with the title "The pupil, the teacher and the scientist: sharing science and technology". This event will give the opportunity to understand Science and Technology coaching, so as to enable all people to feel concerned and to become responsible citizens taking into account scientific and technological developments in our present-day society.

Further information: http://astep2007.emn.fr/

**Junior College Utrecht (NL): Motivating gifted secondary kids for scientific careers**

Traditionally, in Dutch senior secondary schools little attention is paid to differences in abilities within a class. In 2004, Utrecht University and schools from the Utrecht region decided to develop a radical initiative to tackle this issue: the Junior College Utrecht JCU. This is a school for the last two years of VWO (pre-university education). JCU started in 2004 with 25 5VWO students that were selected from 13 schools. It is located at the University College Utrecht campus. JCU-students follow all their physics, chemistry, biology and mathematics lessons in the JCU. The other lessons are followed in their own schools. A special two year curriculum has been developed, taught by eight secondary teachers from partner schools and by a number of university teachers. The initiative was planned as a pilot project for 3 years. In 2005, the 2004 group passed to 6VWO a second group of 50 students (two classes) was selected. In April 2006, the first group took the final examinations. A new group of 50 students was selected and started in August 2006. Many students are interested in participating in the JCU. The 'JCU open day' attracted 170 interested students and their parents. About 75 students are selected by their schools to apply for the JCU. They will be invited for an interview and about 50 students are selected to start in the course.

The JCU has two main goals, one aiming at the education of talented students and one at the innovation of science education in upper secondary schools: to offer an interesting and challenging science education program to talented and motivated students (age 16 – 18) and to provide a working place to partner schools for innovation of the science and mathematics curricula.

As JCU is at the university the secondary school pupils have the opportunity to meet and mix with university students who thus a role model effect on the pupils.

The JCU curriculum has five characteristics that are different from science curricula in regular VWO (general secondary) schools.

1. Accelerated pace: subject matter from the national VWO syllabuses biology, physics, chemistry and mathematics is taught in a shorter time than on usual VWO schools. Thus, a half year time is saved to study topics beyond the syllabuses.
2. More comprehensive: the curriculum is taught in a more comprehensive and profound way than at the regular schools. E.g. the students do lab work using university lab facilities; more attention is paid to theoretical and research backgrounds of syllabus subject matter.
3. Focus on coherence of sciences: as all JCU-students study the full science and maths curriculum, it is possible to pay much attention to the coherence of the sciences and on interdisciplinary projects.
4. Stimulating students' inquiring attitude: there is much room for asking questions and finding answers, for developing their inquiring mind. There is an inquiry curriculum line implying open inquiry assignments in the subjects as well in interdisciplinary projects.

This results in two big investigation assignments guided by researchers from Utrecht University.

5. Enriched program: topics beyond the syllabuses are taught. Seminar or lectures, excursions to a university lab, or of a project or university modules of a large size taught by university specialists, elaborating issues at the front of research.

For further information:
http://www.uu.nl/uupublish/homeuu/onderwijs/overigonderwijs/juniorcollegeutr/30984main.html

**Girls and MST : mentoring, promo-teams VHTO (WITEC) (NL)**

This initiative run by VHTO which is also the national coordinator of WITEC (Women in Science, Engineering and Technology in European Countries) can also be seen as a mentoring or tutoring initiative such as the promo-teams and the mentoring activities. See full description in 3.10. below!

### 3.10. Women in scientific jobs

**Promoting girls in MST, VHTO (WITEC) (NL)**

VHTO, a National expert organisation on girls/women and science/technology makes an effort - in many different ways - to increase the involvement of women and girls in technology education, the technological employment market and government policy. VHTO has a great deal of (quantitative as well as qualitative) data about female technology students and engineers, and up-to-date expertise about technological education and fields of employment. VHTO employs this expertise (among other things) to realise improvement in the following areas:

- Quality improvement and expanding the allure of technology education;
- Supporting junior female engineers and assisting them in their career development;
- Support in the recruitment and career policy of the technological business community;
- Improving the connection between technology education and the knowledge and interests of girls in secondary education.

As a result of being the national coordinator of WiTEC (Women in Science, Engineering and Technology in European Countries) VHTO is able to set up and test initiatives in the field of women and technology with transnational partners. Participation in this European network offers possibilities for translating foreign renewal impulses to the Dutch education & employment market.

VHTO is organising the following activities:

- Speed dating: young girls of about 15 about to make a choice in secondary education, talk with female professionals in science and technology.
- Promo teams: universities involve female students when organising public information and recruitment activities in S & T.
- Mentoring: a woman with broad work experience (mentor) is linked to someone with little experience or to some still in training (mentee).
- Work shadowing: one or more female secondary school pupils or students are taken to the workplace by a female professional.
- Visiting lecturers: they go to schools to give lectures about S & T.
- Equilibrium. This publication concentrates on the combination between worktime and private life time.

- Employable' is a research project on careers of male and female engineers.

For further information: http://www.vhto.nl/

**The Swedish Network Women and Mathematics (SE)**

The aims of the network Women and mathematics in Sweden are: to create contacts between those who are interested in women's/girls' conditions in studies or research of mathematics to spread information on projects and research about women/girls and mathematics, to suggest speakers (preferably female) in subjects concerning women and mathematics and to be a national sub-organization of IOWME (International Organisation of Women and Mathematics), (Grevholm, 1991).

After ten years of activity in the network some additional aims were formulated in 1999*:*

50 % girls in all mathematics courses at upper secondary school, 50 % women in mathematics course at university level, 50 % women among the doctoral students in mathematics, more researcher education programmes in mathematics education must be developed, 40 % women among the senior lecturers at university, five female professors of mathematics. All textbooks at all levels should be inclusive for both girls and boys. All teachers should get in development work and competence development experience from gender perspectives in mathematics education.

The Network Women and mathematics has placed the issue of gender and mathematics on the agenda in Sweden and it contributed to making women visible in mathematics (i. e. video, TV-program) worked on raising awareness of research results on gender issues. It created lasting documentation on gender and mathematics ( i. e. five conference books) and proved that women are there and are willing to contribute in mathematics. It also inspired research and essays by students and teachers on gender issues.

The network is one long-lasting intervention programme and must be visible and active. Such a programme is one possible efficient way to implement research into practice, express criticism and create action and activity based on research. The evidence that supports this claim consists of the collaborative work of many women over a long period of time. It is the efforts of many teachers and women in education over many years that create the success of the network.

All the initiatives and actions are taken by members in the network. A sixth conference took place in 2005 with still more research presentations than before. A group of four younger women was elected to lead the network as the founders withdrew. The next conference will be in 2008. New members register regularly in the network. The international Newsletter of IOWME is distributed regularly.

For further information: http://www.mna.hkr.se/matematik/kvinna/english.html

**The ROSE research study**
(see under research)

### 3.11. Projects involving cities, regions etc.

**The Ariane cities project (a.o. FR)**

The Communauté des Villes Ariane (the community of Ariane cities) is a network of about twenty European cities involved in the ARIANE programme. The purpose of the Network is to promote education and training in Space activities by:

- facilitating interactions between those involved in secondary, vocational and university training,
- encouraging the development and dissemination of new teaching methods,

- stimulating students' curiosity and interest in scientific disciplines and encouraging them to choose these study options,
- enabling students to meet and interact with the relevant education authorities.

**Different activities set up:**

Intercultural Seminars that have already become a tradition ( this year end of March). The 30 young participants from across the nine cities can visit the EADS facilities, visit Paris and continue learning about the importance of European cooperation in space.

Scientific Holidays for high school students in Toulouse. These Holidays bring together 25 high school students from 9 Ariane cities for a very successful programme of scientific and intercultural activities. The full-day visit to the Cité de l'Espace (Space city) is one of the highlights, as it provides an ideal learning experience on space science, engineering and applications.

Summer School for aerospace engineering students and young professionals is a four-week course bringing together students and young professionals from the nine cities. The course focuses on the next generation launchers for Europe, as well as their ground facilities for propulsion testing and launch. The syllabus starts with one day of intercultural training and team building exercises, and takes advantage of the space propulsion test range at Lampoldshausen and the availability of expert lecturers from Arianespace, CNES, DLR, EADS-Astrium, ESA, SNECMA/Safran, and the Universities of Bremen, Liege, Toulouse and the International Space University.

The "REVA internet portal project" is the virtual platform for meetings, data sharing and dissemination for REVA: *Réseau Educatif des Villes Ariane* (Ariane Cities Education Network).

http://www.villes-ariane.org/

**Municipal Maths education supervisors (ambassadors), (SE)**

To support teachers and coordinate all the positive forces promoting better maths learning and teaching, it was decided to launch in Sweden a network of municipal maths supervisors composed of experienced maths teachers called Matematikutvecklare. They are not inspectors but have to be seen more as pedagogical advisors for maths. The network is the responsibility of the municipalities.

The supervisors or ambassadors are selected and appointed by the municipality with the clear mission to promote maths education and to support teachers of maths at the level of (action-) research and development work. The development work they do is seen in the long-terms and thus doesn't have a short term approach. They may be exempted part-time of teaching or not as this depends upon the decision of the municipality for which they work. Maths supervisors have to attend 3 conferences(two two-day conferences and a one-day conference: 5 days in total) a year as training when they become maths supervisors.

They are involved in the following activities: share and disseminate good practice and experience amongst maths teachers, be involved in Research and development work in Maths and develop the network of teachers at municipal level. Some of them are also actively involved in Learning study/Lesson study activities to promote professional development of teams of teachers in schools. They are supported by a website: http://www.matematikutvecklare.se

Each municipality has also received a set of support materials – books and manuals – that can support the work of the Maths supervisors. it gives the supervisors information/knowledge about actual research and development work and projects in maths. It gives possibilities to share experiences about development work in mathematics. It gives to the maths supervisors examples of how to plan, implement and evaluate development work.

It contributes to create and develop networks on a local, regional and national level. They are aimed to be a link between schools in the municipality, the university, the university college, teacher education institutions. There are 22 such centres in Sweden and they get funding from National Agency for School Improvement to support the supervisors.

In each municipality there is a local educational authority and a head of the local educational authority. These heads usually have their own networks in which they discuss issues concerning school. There are about 20 such networks in Sweden. The heads of the local educational authorities and the networks are informed during a personal visit of representatives of NCM so that they can give a good support to the supervisors.

### 3.12. The evaluation of Innovative pilot projects

**Mid-term review of the Dutch Delta Plan Science and Technology**

A midterm review of the Delta Plan Science and Technology was carried out by Organisatie- en Adviesbureau B&A Beleidsrendement. independent audit commissions evaluated each of the sub programme . Afterwards a global review was also made This showed the strategies applied to be successful overall but it also showed that in certain areas the targets were not (yet) achieved. The review also showed that the Platform itself is the right structure to help to implement such a major plan to promote science and technology. Key is the sustainability of the efforts in the future once the plan comes to an end.

Based on this review new key elements are focused upon for the final two year of the plan:

- The professional development of present and future teachers;
- Turning schools into learning organizations;
- Enhancing the mobility of science teachers from secondary schools to higher education,
- Offer research possibilities for science teachers of schools for some years;
- Attracting more girls into science and technology studies / jobs and
- Promoting science and technology with students of migrant / disadvantaged origin.

**The evaluation of the Main à la Pâte Initiative: a comprehensive grid (FR)**

The Lamap has developed an evaluation grid to be used to observe the way in which the teachers apply in science education the inquiry-based science education approach in their classroom. The evaluation grid is used to measure the impact of the monitoring and support put in place by the 15 resource centres of Lamap to help teachers implement the IBSE method. the final objective of the use of this grid is to see to it that the resource centres get information to improve the support and monitoring they give to the science teachers and the schools.

As mentioned earlier the 15 resource centres give different kinds of support and monitoring to science teachers: they organise in-service training, they give individual support to teachers in the classroom, the give support over the Internet or there is support by scientists also in the classroom. Furthermore the teachers receive several kinds of resources: pedagogical documents, kit on certain themes of the science programme. It is expected that after 3 years of monitoring and support 75% of the teachers in one geographical area will use and apply the IBSE approach.

When an evaluation tool had to be developed to assess the way in which the teachers applied the IBSE approach it was decided to use an observation grid and not a questionnaire. The tool had to be sufficiently simple so that many observers could easily use it. It had to be specific enough to be able to distinguish between the IBSE approach in a class and other ways of working. The grid was developed by the team of the Lamp in close cooperation with academic representatives of the Latin American country, Colombia, plus representatives of the Lamap resource centres.

A pilot grid was developed and tested in 22 classes by a dozen of observers, two per class.

The observation grid focuses on 22 characteristics to be observed and for each characteristic there are 5 levels of appreciation. As to the 22 characteristics 4 focus on the contents of the classroom session, 3 focus on the material and the infrastructure in the class available, 7 focus on the activities of the teacher, 4 on the activities of the pupils and 4 on the written work or traces produced by the pupils in the special cahiers of logbooks they use individually or in group. The 22 items are grouped into 6 large categories and a weight is assigned to each of those.

Between 2002 and 2007 some 60% of the teachers involved in the Lamap activities have benefited from this evaluation exercise with the grid. The results show that many teachers successfully apply the IBSE approach but that further attention is required in specific areas.

For further information: http://www.lamap.fr

**Evaluation of the first strategy for MST in Norway**

The second MST Strategy: "A Joint Promotion of MST" in Norway 2006-009 was developed taking into account the conclusions and the recommendations of the **evaluation of the first strategy** carried out by an external independent consultancy company, Ramboll Management. This evaluation looked at the following elements: the impact, the relevance, the way in which the 1st strategy had been implemented and the utility and the sustainability of that strategy.

As to the impact the evaluation report stressed that there was no baseline to start from, that there was no clear goal structure and that there were no indicators mentioned in the strategy to measure the effect. The impact on the teachers was also found to be limited probably due to the low level of teacher qualification as to MST. The evaluation, however, pointed at the fact that many teachers wanted to specialise in MST and update their qualifications. It also highlighted the insufficient recruitment of MST teachers and the lack of urgency by school heads and school owners (the municipal or county authorities) to deal with this problem. The evaluation pointed out that the more the teachers are motivated for MST (by being better trained in MST) the more motivation is created with the youngsters'.

As to the relevance the evaluation pointed out that initiative set up within the 1st strategy are relevant but it revealed that the goal structure was too complex. There was too much focus on outputs and not enough on the possible impact. It showed that the absence of indicators made it hard or impossible to measure what had been achieved.

As to the implementation of the strategy and the way in which the plan was governed, the evaluation pointed out there was an impressive commitment of all the stakeholders and there was a relevant organisational structure. It showed that not enough use was made of result based management and the governing signals had been weak. Reporting proved to be rather superficial and that not enough attention had been given to follow-up activities during the implementation.

As to the utility and sustainability the evaluation pointed out that there was a lack of documented results. Hence it was difficult to show the utility and to pinpoint elements that proved that the changes brought about were sustainable towards the future.

The main specific recommendation of the evaluation was to focus on the further qualification of teachers as the better the teachers are qualified the more impact they had on motivation and attitudes as to MST learning with themselves and with the pupils. The main general recommendation was to focus on more measurable goals and to have less goals overall in such a strategy plan. Better documented results and outcomes had to be more clearly communicated to all stakeholders which would also contribute to sustainability. It was also suggested towards the future to work with performance management based on clear indicators.

**Performance management** starts from the impact expected or wanted, defines the results, focuses on the output and only then sets up and implements the activities to reach the impact expected. Too often policy plans start from the activities and go the other way around. Performance management can be either evidence-based or based on presumptions or a combination of both.

The 7 steps of performance management are: establish impact goals, establish a theory of change, develop indicators, set up monitoring measures, organise monitoring reporting, schedule evaluation, and finally focus on clear reporting towards all the stakeholders.

### 3.13. Research in science education

#### Research studies, projects and support

#### The ROSE project and recruitment to MST, attitudes and gender issues

ROSE, The Relevance of Science Education, is an international comparative project shedding light on affective factors of importance to the learning of science and technology. Key international research institutions and individuals have worked jointly on the development of theoretical perspectives, research instruments, data collection and analysis. The target population is students towards the end of secondary school (age 15). The research instrument is a questionnaire mostly consisting of closed questions with four-point Likert scales. The rationale behind the project, including the questionnaire development, theoretical background, procedures for data collection, etc. is described in a publication available in pdf or print format*: Sowing the seeds of ROSE.*

http://www.ils.uio.no/english/rose/key-documents/key-docs/ad0404-sowing-rose.pdf
The lack of relevance of the S&T curriculum is probably one of the greatest barriers for good learning as well as for interest in the subject. The outcome of the project are empirical findings and theoretical perspectives that provide a base for informed discussions on how to improve curricula and enhance the interest in S&T in a way that it respects cultural diversity and gender equity, that it promotes personal and social relevance and that it empowers the learner for democratic participation and citizenship.

The key feature of ROSE was to gather and analyse information from the learners about several factors that have a bearing on their attitudes to S&T and their motivation to learn S&T. Examples are: A variety of S&T-related out-of-school experiences, their interests in learning different S&T topics in different contexts, their prior experiences with and views on school science, their views and attitudes to science and scientists in society, their future hopes, priorities and aspirations, their feeling of empowerment with regards to environmental challenges, etc.

Particularly interesting are the findings that girls have a more idealistic profile. This means that they want to improve the world, to work in the reality of the world and to care for people. They thus are

less interested in money and prestige. This show that idealistic values should be integrated in the teaching of MST so as to create more interest with girls. More efforts should be invested in showing how the diversity of values can be integrated in MST careers . MST and related careers and jobs should be more presented as exciting and cool, as important to the sustainable development of society and as enabling women to develop themselves fully. At the moment there is still too strong a link between MST and the nerds, people interested in abstract things, disconnect from society and from the social context. To attract more girls in MST efforts have to be made to connect SMT to society and to link it closely up with the social context and societal issues that our present-day world has to face. Women in scientific careers have to be presented differently focusing on feminine characteristics.

ROSE is supported by The Research Council of Norway, The Ministry of Education in Norway, The University of Oslo and the Norwegian Centre for Science Education.

**The PISA+ project (Norway)**

**The PISA+ project** addresses how teachers organise teaching and learning in their science class by making and analysing videos of science classrooms. The objectives are to enhance the reflection on the organisation of teaching of learning in the science classes and the improvement of those activities. The concern to link up research with classroom practice is always clearly present.

The research project was established to pursue and enlighten problematic PISA findings in the Norwegian context in mathematics, science and reading. The PISA+ project is organised as an integrated collaborative research project between junior and senior scholars at the Faculty of Education. The projects group is cross disciplinary and involves scholars from maths education, science education, language arts and general education/ didactics. The PISA+ project is based on two different sources of funding from the Norwegian Research Council.

The data is collected by video, observations and interviews. Three cameras are used: one following the teacher; one over-viewing the classroom; and one focusing on a small group of students. In addition, focused and purposive interviews with students and the observed teachers have been conducted. The informants are given opportunity to comment on the lesson videos. Each lesson is followed by a students' interview, with different students for each lesson. The teachers are interviewed about one selected lesson a week.
There are three main categories used in the general analysis with a focus on the teacher:

- the whole class instruction;
- teachers' activities during individual seatwork;
- teachers' activities during group work.

Each category is subdivided into several codes.

In this way it is possible to compare science, math and Norwegian lessons, see whether special profiles of teaching strategies for the different subjects can be found. It is also possible to give an overview of teaching strategies at the activity and organisational level in ninth grade classrooms.

After the quantitative analysis this information is used together with other observations, information from earlier studies and educational insight to do qualitative analysis closer related to each subject; science, math, and reading. Also teachers' mode of guiding students and new teaching tools; as work plans and work sessions, are explored. Both the teachers' and the students' perspective are given attention.

The analysis as to the teaching activities showed that teachers use very often dialogue instruction, questions and answer sessions and task management in a whole class instruction model. They worked less with groups within a class. The analysis also shows that teachers spend little time on summing up the knowledge acquired at the end of a learning period. They also spend little time on going over homework. The analysis also showed that there little science talk between pupils.

**Mind the gap, 7FP project, coordination: Norway**

The starting point of the drafting of the 'Mind the Gap' project was the Rocard report "Science education now: a renewed pedagogy for the future of Europe" published in 2007. At the moment there are different gaps in science teaching and learning: the gap between theory and practice, the gap between teaching and learning, the gap between research policy and practice, the gap between educational policy and in-service teacher training and the gap between cognitive demands and available resources.

The project will gather, exchange, develop and disseminate good practices in inquiry-based science teaching (IBST). IBST wants to promote authentic and problem-based learning attitudes, hands-on activities, self-regulated learning sequences emphasizing student autonomy and discursive argumentation and communication with peers talking science.

IBST refers to learning and instruction design that engages students in authentic problem-solving activities that pay attention to diagnosing problems, integrating experiments, distinguishing activities, planning investigations, researching conjectures, searching for information, constructing models, debating with peers and formulating coherent arguments.

The overall aim is to stimulate a more engaging and interesting science teaching based on principles of IBST so that more young people in general, and girls in particular, wish to pursue education and careers in science and technology.

The following aspects are addressed in the different work packages:

- Frameworks for IBST: national educational policy and IBST, scientific literacy, the role of teachers, students and curricula as to IBST;
- Scientific literacy in IBST: bridging the gap between policy and teachers; focus groups involving parents, teachers and politicians will be involved;
- Communication and argumentation in IBST in the classroom; good practice in some countries; the use of socio-scientific issues in science teaching;
- Investigating ICT tools for IBST;
- Dissemination of the outcomes and professional development of teachers; models for teacher professional development at work.

**Research support structures**

**The National Research School for doctoral students in MST of Norway**

The activities of this recently created National school or research are a.o. contributing to goal C of the MST strategy in Norway: viz. The development of MST in higher education and in research.

The National Research School for doctoral students in MST in Norway has been set up at the University of Oslo in close cooperation with the national Norwegian research network.

One of the reasons for creating this National research centre was the fact that many MST teachers that teach at teacher training colleges of the university colleges do not have a PH.D. As mentioned earlier the absence of PH.D. makes it impossible to set up Master courses in those institutions of

higher education. Measures have already been taken to do something about this as the government has made available scholarships to university college lecturers to get a PH.D. at the University of Oslo. Through the activities of the National Research School of Norway it is hoped to increase the interest for and the quality of MST teaching and learning

The National Research School intends to bring expertise together available in different universities in faculties of education and in faculties of sciences. Candidates from across Norway are able to take a PH.D. at this national research school. They are brought together for courses and other networking activities. The students can get funding for three years. At the moment there are 10 PH.D. students in science and 10 PH.D. students in maths. There is definitely a potential to have more students as some 30 students – mostly teachers or teacher trainers – are interesting in studying at the National Research School. They would leave their teaching jobs for the three years of the PH.D. in special circumstances it can be extended to a four-year period. The students do not have to be necessarily involved in the doctoral programme of the university of Oslo to be allowed to the National Research School of Norway which is located at the University of Oslo.

### 3.14. Support structures

#### The Netherlands

#### The Platform Bèta Techniek (Science and Technology) (NL)

The implementation of the Delta Plan Bèta Techniek is the responsibility of the Platform Bèta Techniek since 2004. 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. It is in its structure a Foundation which is a non profit organisation implementing the policy decided by the government. The aim of the activities of the Platform is 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 will exist from 2004 to 2009.

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 subprogrammes outlined in the compendium: see the description of the Delta Plan Science and technology (NL)
http://www.deltapunt.nl/

The focal point are the clearly targeted agreements with different kinds of institutions: with primary schools (1930 involved in April 2007 ; 2500 in 2008), 250 general secondary schools (Universum- en Jet-Net schools) 47 lower secondary vocational / technical schools (target100-150 in 2008); 10 upper secondary vocational / technical schools (target 30) and all universities and universities of applied sciences with science and technology departments. Agreements are also target an increasing number of industrial sectors and companies. All of them have to integrate the strategy of the Delta Plan on Science and technology in their institutional policy. For 2007 the Deltaplan Bèta Techniek could dispose of 58,3 MIO EURO. Partly ESF funds. 60 MIO EURO are also available (2006-2009) for the professional development of teachers and for improving facilities in secondary education.

To reach its objectives the Platform builds on a well structured cooperation between the government (o.a. Ministry of education and science), education & training and the world of industry. The platform is the 'middleman' the spider in the middle of the web, the stimulator and catalyst to see that the objectives of the Delta Plan are reached.

A midterm review was carried out by independent audit commissions for each sub programme . This showed the strategies applied to be successful. Based on this review new key elements are focused upon for the final two year of the plan. The professional development of present and future teachers; the mobility of science teachers from secondary schools to higher education., research possibilities for teachers; attracting more girls into science and technology studies / jobs and promoting science and technology with students of migrant / disadvantaged origin.

The Platform is investing in the final phase in enhancing the sustainability of what has been set up once the Delta Plan comes to an end (2008-2009). A final review is schedules also at the end of the Delta Plan Science and technology.

**France**

**A support team and 15 resource centres for La Main à la Pâte**

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 important 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 financial 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.

**Cité de la Science et de l'Industrie, la Villette, Paris ;**

The activities of the Cité de la Science et de l'Industrie are a good example of scientific cultural mediation. The objective of scientific cultural mediation is to make science and scientific culture more accessible to all layers of the public ranging from pupils, youngsters to all groups of adult learners. It organises different activities. http://www.cite-sciences.fr

*The Villette classes,* allow a primary or secondary class to spend a week devoted to the study of a scientific or technical topic in Paris. The stay is spent mainly in La Cité des Sciences (min. 4 half-days) and also enables the classes to make use of the scientific and cultural resources of the Paris area.

*The international classes La Villette « Sciences in French* » are organised for foreign pupils (15 - 19 years) who have learned at least for 3 years French at school. The four day event enables pupils to implement a pedagogical project, in French and to work in an interdisciplinary way. Such classes give the opportunity to pupils to meet other pupils from other countries and to set up a real linguistic and cultural exchange focusing on scientific themes .

The teacher of the visiting pupils attends a four-day preparatory session and builds the programme of pedagogical activities with the mediator in charge of the specific theme to be addressed. This visit enables the teacher to discover the permanent and temporary / special exhibitions on various themes. Teacher can chose the way in which work will be done with their pupils so that they can well prepare and follow-up the work of the pupils during their four-day stay at the Cité La Villette.

The objective of the Villette discovery classes is to have pupils learn in an environment where plenty of resources, information and support are available. It contributes to the development if the autonomy of the pupils and it stimulates their interest and curiosity. Experience shows that motivation is largely increased for science and technology when they are confronted with science and technology in a creative and very often playful way.

**The Villette project class** enable teachers to work on a theme of their choice or on an experimental topic proposed by the Cité des Sciences. A project class requires a special commitment of the teachers and is a particularly rich teaching adventure. The project classes last four days: two days are standard for all pupils and the other two days take into account the wishes of the teachers. The teacher atten a preparatory session to build the programme with the mediator. Thus the class links up with the pedagogical project the pupils are working on at school.

**The project Cité en alternance (City in alternation**) targets pupils and their teachers of classes of the lower secondary schools (colleges) in an education priority area (ZEP- disadvantaged schools) near to the Museum. Alternating work in the museum and work at school pupils acquire knowledge, skills and attitudes while getting acquainted with a place of scientific and technical culture. Teachers discover the resources, try out pilot activities and acquire varied methodological tools to build their own project. The project has extended successfully gradually since 1997.The pupils registered benefit from an individual subscription to the City of sciences and of industry: they come either with their professors during school time, or on an individual basis out of school time.

**Sweden**

**The National Centre for Mathematics Education, NCM**

NCM of the Göteborg University, is the Swedish national resource centre for mathematics education. Its main task is to support the development of Swedish mathematics education in pre-school, school, and adult education. Its major target groups are thus practising teachers and teacher trainers in mathematics education at all ages including adult education.

It has a major website http://ncm.gu.se of which the aim is to make available valuable resource for teachers, teacher trainers, researchers and young students to enable them to provide concrete and continual support that can be a tool in the day to day work

An important part of NCM's work is the journal ***Nämnaren*** **(**Denominator) and the related series of books *Nämnaren TEMA*). Nämnaren is a gigantic virtual staff meeting where teachers can exchange

ideas, good practice, reflect on maths teaching and learning etc. Everybody can contribute to this journal based on his or her practice or research. The NCM also publishes the mathematics journal *Normat* (Journal of Nordic Mathematics). In addition to these journals the NCM publishes reports, reviews of research and support material. The NCM runs the Kangaroo competition to promote maths.

NCM takes part in planning and contributes to exhibitions and lectures, especially in the **biennial mathematics events at national level**, as well as other conferences. Biennials are arenas where teachers meet, discuss, exchange ideas and good practice and listen to researchers. In between the Biennials involving 3500 to 5000 teachers smaller biennettes are held at regional level. NCM's assignment from the government also covers initiatives for adults learning mathematics.

NCM undertakes assignments if they are part of planned long-term development measures in schools and municipalities. It cooperates with the National Agency for School Improvement, universities, university colleges, the municipalities and individual schools is intense and developed continually. NCM is strengthening collaboration with and between the national network, organizations, associations, committees and those concerned with the environment who can contribute to the development of Swedish maths education

The NCM is cooperating with top representatives of the Swedish industry about the support and cooperation on the development of mathematics education in Sweden. The activities are linked to the ERI, the European Round Table of Industrialists.

NCM also has a very extensive international network of researchers and institutions in mathematics education around the world.

NCM's reference library on the literature of mathematics education contains more than 5 000 volumes and 80 journals. Information is also provided on a regular basis about new acquisitions and journals with brief descriptions of the content of current articles.

**Nordic Graduate School in Mathematics Education (NoGSME),**

NoGSME is an independent organisation that works in close cooperation with other organisations such as NCM to improve maths education.
Its aims are:

- To support and develop education of researchers in maths education in Nordic and Baltic countries;
- To create constructive cooperation to raise the scientific quality of research in maths education;
- To give doctoral students in maths education access to the activities of the Graduate School;
- To create cooperation among a greater group of doctoral students and supervisors in order to share experiences and opportunities to improve the education of researchers. This even after the five years of the Graduate School.

The Nordic Graduate School in Mathematics Education is involved in the following activities:

- Common courses created with the added competence from all researchers in the Nordic countries and international partners;
- Summer schools building on earlier good experience from similar arrangements;
- Seminar-series in specific research areas as a complement to local series and workshops on subjects or issues of main importance;
- Competence development for maths supervisors and exchange of experience;

- Partnership and collaboration with distinguished international scholars;
- Creating a database for ongoing work, theses and greater development work in maths education;
- Granting mobility stipends and special financial support for doctoral students.

It is also cooperating with the other National Graduate Schools as the Finnish Graduate School in mathematics and science education, the Swedish Graduate School in mathematics didactics 2000-2006, 21 doctoral students were taken up, 8 has finished so far, the Danish Graduate School in mathematics and science education started 2004.

The Nordic Graduate School is situated at Agder University College in Kristiansand, Norway and financed by NordForsk 2004-2008

**NAVET (The Hub) or Science Centre in Borås**

The NAVET centre shows how a science centre can contribute actively to increase the interest in and motivation for mathematics with children in compulsory education.

Navet is the natural science centre of Borås - an inspirational place containing masses of enjoyable experiment stations that are both instructive and exciting for adults and children alike!

Within the NAVET (HUB) Science Centre a special area - Bagdad - is dedicated to maths. The visit of school children is composed of a pre-assignment given to the pupils before they come to the centre, when they arrive there is a drama played by the staff and then during the visit there is all sorts of mathematical games in which they are the active players. The variety of games is very large to stimulate the interest and the use of various skills with pupils.
The schools can also take back to the school boxes with further pedagogical material related to maths and science which then they can use once they are back in their classroom. The Centre also works with The initial teacher training department of the regional university college, Högskolan Boräs, and with in-service teacher training centres. NAVET also has a travelling exhibition that can go to schools.

http://www.navet.com/information_english.html

**Norway**

**The Norwegian Centre for Science Education**

The centre is a national resource centre for science education (SE) (kindergarten, primary and secondary school, adult education and teacher training). The vision can be summarised in the following key word IMEN (seed): Kompetense (Competences), Inspirasjon (Inspiration), Engasjement (Engagement / commitment) and naturfag (sciences). The word KIMEN also stands for the 'Budding' scientists which can be supported at different levels of the education system.

Its main objective is to enable pupils and teachers to consolidate competence and motivate interest in natural science by developing and improving content and methods through research, experiment and development projects. The centre contributes to actions aimed at increasing the recruitment to scientific and technical studies. It seeks contact with societies of science education on a national, Nordic and international level and has an important research group focusing on MST issues.

Its target groups are teachers of natural science in primary and secondary education and teacher training, students, researchers, and developers of teaching material in topical fields.

It cooperates with universities, university colleges, museums, primary and secondary schools and industry. It leads and coordinates activities to develop working methods, content and examples of teaching material which contribute to make natural science education diversified, exciting and alive to pupils and students. It contributes a.o. to developing and testing computer based learning materials and to organizing web based learning environments in natural science.

The centre contributes to disseminating results from research, experiment and development projects through periodicals, websites, annual conferences and seminars of teachers, science ambassadors that disseminate innovation in science education. The centre is involved in the development of in-service training and further education. It helps to develop positive attitudes and a thoughtful view of natural sciences in society. It assists the Ministry of Education and Research and the Directorate for Education and Training with advice when it comes to curriculum development and pupil assessment in natural science. It collaborates with other national centres and advisory councils to see to it that science work is coordinated in a good and functional way. It promotes equal opportunities in natural science education.

The centre is localized at the Faculty of Mathematics and Natural Sciences, at the University of Oslo. Website: http://www.naturfagsenteret.no/mandat_en.html

**The Norwegian Science Centres**

Seven science centres have been or are being developed across the different regions of Norway to support science learning and teaching. They are an explicit element of the strategy to promote MST across Norway especially as to goal E of that strategy: Increase the MST competence and improve the communication to the general public. The science centres are to work locally and to cooperate and network nationally.

They main objective of the science centres is to make science more accessible not only to young people but also to the large public. The focus is on communication about science through exhibition that can be visited by various target audiences. More and more the science centres cooperate with museums so as to put science in a cultural and historical perspective. All the seven science centre also run in-service training courses for teachers to support them in the teaching and learning of sciences.

As the science centres are part of the overall strategy for the promotion of MST a clear indicator has been worked out stating how during the strategy for MST the numbers of visitors to those centres have to be increased. The visitors should have been increased by 20% over the period 006 – 2009 but already after one year the increase of visitors had reached 30% which was beyond expectations.

They are funded by the local government and private companies and get support from the Ministry of Education and Research and the Ministry of Culture and Church Affairs. The contribution of the Ministries is limited so that other activities have to be developed to generate extra income.

**The Norwegian Centre for Mathematics Education (NCME)**

The NCME primary task is to lead and coordinate the development of new and improved working methods and learning strategies in the maths education, from kindergartens through teacher education in Norway. It also contributes to a Nordic cooperation.

Its primary targets are first and foremost teachers teaching maths in schools and teacher education, teacher students at Colleges and Universities and teaching aids developers. In order to build a

general positive view at maths, parents, media and the public are also important targets for its activities. It addresses itself to children and adults of all ages.

The NCME develops various activities to promote maths learning and teaching:

- Maths clubs for small children;
- Evening classes of maths for parents;
- Public and media activities / events to draw the attention of the large public to the importance of maths in society;
- Laboratory exercises are to help teachers;
- Outdoor activities for maths;
- National test development;
- Guest lecturers are invited to the centre for one term; during their stay that are involved in various training and support activities.

The NCME works with maths resource persons that can help teachers across the country to developing new approaches to maths education. Those resource teachers are very experienced maths teachers who are not paid to do the job and who are no exempted of any classroom activities to do this supplementary job.

Website: http://www.matematikksenteret.no/english

**4. Some useful websites**

The websites mentioned below are directly linked to the four PLAs organised so far. They have been mentioned or referred during the different activities of the PLA.

**Netherlands**

Website Ministry of Education, Culture and Science, Netherlands (English!)
http://www.minocw.nl/english/index.html

Platform Bèta Techniek
http://www.deltapunt.nl/

Website Axis Foundation (predecessor of Delta Plan & Platform)
http://www.platform-axis.nl/

Jet-Net
http://www.jet-net.nl/start.html

Junior College Utrecht
http://www.uu.nl/uupublish/homeuu/onderwijs/overigonderwijs/juniorcollegeutr/30984main.html
(Dutch information)
http://www.nnv.nl/NNV/DATA/Downloads/FYSICA2006/Ton%20vd%20Valk%20-%20paper.doc
(Article in English)

VHTO
National expert organisation on girls/women and science/technology
http://www.vhto.nl/

WITEC
Women in Science, Engineering and Technology
http://www.witec-eu.net/

Freudenthall Institute for science and mathematics education
http://www.fi.uu.nl/fisme/en/

Stichting Techniekpromotie (students of TU Eindhoven promoting MST)
http://www.techniekpromotie.nl/

Amstel Instituut (University of Amsterdam)
Faculty of natural sciences, Maths and Informatics
http://www.science.uva.nl/amstelinstituut/english.cfm

Next generation Science (cooperation in sciences between UK-NL)
http://www.britishcouncil.org/netherlands-cf-ngs-rotterdam-report.pdf

Durven, Delen, Doen (Programme Dare, Share, Do: to support Innovation in secondary education)
http://www.durvendelendoen.nl/

Casimir programme (NWO) Mobility of researchers

http://www.nwo.nl/ (Nederlandse Organisatie voor Wetenschappelijk Onderzoek) see: subsidiewijzer

NEMO: Science Centre Amsterdam
http://www.e-nemo.nl/print_detail.php?id=5&s=85&d=551

ESERO project of ESA
http://www.esa.int/esaED/SEME3W59CLE_teachers_2.html

Kookdroom Foundation / Fifteen Amsterdam Restaurant
http://www.fifteen.nl/index.php?onderdeel=fifteen&menu=82

A Joint promotion of Mathematics, Science and Technology (MST) Strategy 2006-2009, Norwegian Ministry of Education and Research
http://www.naturfagsenteret.no/Strategiplan2006_eng.pdf

**Sweden**

The Swedish National Centre for Mathematics Education, NCM, Göteborg University
http://ncm.gu.se

The official gateway to Sweden
http://www.sweden.se/

The Swedish National Agency for Education,
http://www.skolverket.se/sb/d/354

National Assessment and Grading in the Swedish School System
The Swedish School System and Steering documents
http://www.skolverket.se/publikationer?id=1524

The Swedish National Agency for School Improvement
http://www.skolutveckling.se/in_english/

The Swedish National Agency for Higher Education
http://www.hsv.se/2.539a949110f3d5914ec800056285.html

The Ministry of Education and Research
http://www.sweden.gov.se/sb/d/2063

The Government and the Government Offices
http://www.sweden.gov.se/

The Riksdag
http://www.riksdagen.se/default____56.aspx
Statistics Sweden, Education and Research

Webmaths
http://www.webmaths.com.au

European Round Table of Industrialists
Working group societal changes: focus on sciences and maths
http://www.ert.be/working_group.aspx?wg=102

**France**

The French Ministry of education:
http://www.education.gouv.fr/

La Main à la Pâte main website
http://www.lamap.fr

The PRESTE plan for renovation in science teaching and learning
http://www.education.gouv.fr/bo/2000/23/ensel.htm

EIST : Enseignement Intégré des Sciences et de la Technologie
http://www.academie-sciences.fr/enseignement/guide_06.pdf

The common base of knowledge and skills in France
http://www.education.gouv.fr/bo/2007/hs6/default.htm

Detailed information on the common base for knowledge and skills in ENGLISH:
http://media.education.gouv.fr/file/46/8/5468.pdf:

More information in FRENCH can be found on the following website:
http://www.education.gouv.fr/cid2770/le-socle-commun-connaissances-competences.htmlhttp://www.education.gouv.fr/cid2770/le-socle-commun-connaissances-competences.html

The High Council of Science and of Technology and its opinions on the young people's disaffection for the scientific studies can be found on the following websites:
http://www.enseignementsup-recherche.gouv.fr/conseil/hcst/index.htm
http://www.enseignementsup-recherche.gouv.fr/conseil/hcst/avis.htm.

National Centre Of Pedagogical Documentation (CNDP).
http://www.cndp.fr/ecole/programmes/accueil.htm

The science programmes of the primary school :
http://eduscol.education.fr/D0048/primprog.htm

Cité de la science et de l'industrie de la Villette
Website: http://www.cite-sciences.fr ;
Then go to "éducation"

**Norway**

The Ministry of Education and Research:
www.kunnskapsdepartementet.no

The Education Mirror: 2006
Analysis of primary and lower and upper secondary education in Norway
http://www.udir.no/upload/Rapporter/Utdanningsspeilet_2006/The_Education_Mirror_2006.pdf

The Internet Gateway for Education : www.utdanning.no

The Directorate for Education and Training: www.utdanningsdirektoratet.no

The School Web: www.skolenettet.no

The Internet Gateway for applicants to upper secondary education:
www.vilbli.no

Mathematics
http://www.matematikk.org

Natural sciences (in Norwegian)
http://www.viten.no

Northern lights
http://www.northernlights.viten.no

Global warming
http://www.globalwarming.viten.no

Gen Technology
http://www.genetechnology.viten.no

Sustainable development (partnerships between schools)
http://www.sustain.no