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DG Education and Culture

## CLUSTER

## "MATHS, SCIENCE AND TECHNOLOGY"

### PEER LEARNING ACTIVITY (PLA)

organised by  
the National Centre for Mathematics Education,  
Gothenburg University, Sweden  
in cooperation with DG EAC

### REPORT

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Report, PPT presentations and documents: see website:  
<http://ncm.gu.se/node/1959>

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## Executive summary

The objective of the PLA was to study **the comprehensive Mathematics Action Plan set up by the Swedish Ministry of Education and Research. This action plan was developed by the Mathematics Delegation on behalf of the Ministry of Education and Research and the Swedish National Agency for School Improvement** to enhance maths education as an integral and integrated part of the whole education. **The Swedish Action Plan aimed at increasing the interest in maths "at the light of the goals set up by the European Union for 2010".** Maths education is seen as an important and major contribution to education in a "*Bildung*" perspective. Maths is also seen as a lever for powerful and lasting innovation in all areas of education. Maths education is closely linked to and integrated into as many areas of the curriculum as possible so as to enrich the whole educational process at all stages and at all levels involving all key stakeholders of the educational community.

**Representatives of 9 European countries** (CY, DE, DK, FR, IS, NL, NO, PT, SE, the external consultant and the representative of DG EAC) participated in this four day events. The group was composed of 13 experts plus of a varying group of Swedish participants bringing the group during some days to 25 participants. **The perfect organisation by the Swedish hosts, the balanced programme with stimulating visits and lectures by external Swedish experts and the interactive group discussions in which all the participants to the PLA participated actively have turned this PLA into a real success and into an exciting learning experience.**

The PLAs are with **no doubt having a major effect inspiring national initiatives and strategies.** The reflection within the Cluster at the beginning of this PLA showed that **the PLA in the Netherlands (November 2006, *Deltaplan for Science & Technology*) has resulted in further contacts and exchanges with the Dutch initiatives. Furthermore the model of cooperation between Dutch education and industry to promote science and technology has also inspired several countries to take similar initiatives.** This is also the case for other initiatives discussed during the PLAs such as e.g. the visits to science centres and science museums, cooperation between schools and companies, and mentoring partnerships university/schools.

The present PLA in Göteborg focused on the following **key elements:** information about the Swedish education system in general and maths education in particular; a clear description of way in which the strategic action plan had been developed and started to be implemented, the specific standpoints, the actions and operational activities to be implemented over several years; visits to schools, science centres, Chalmers University of Technology and Göteborg University; meetings with key experts of the National Centre for Mathematics Education; meetings with key experts of the Ministry of Education (e.g. in charge of initial and in-service teacher education) and of the National Agency for School Improvement; meetings with representatives of universities and university colleges. **This enabled the participants to meet many stakeholders involved at the different levels in the promotion of maths education and the implementation of the strategy in the area of maths education.** It should be stressed that a large variety of stakeholders were consulted during the work of the Maths Delegation ranging from teachers associations, teacher training associations and centres, local and regional authorities, science academies, universities, parents, industry and business etc. etc.

**The whole Action Plan** to improve the learning and teaching of mathematics is clearly based on a **well-structured analysis** which is reflected in the "Report of the Maths Delegation", a group of key experts reflecting all the stakeholders of the educational community as to maths education appointed by the former Government

and with a clear mandate. The Action Plan also built on what had been achieved so far incorporating all successful initiatives that had been developed in maths education so far. The Report of the Delegation made clear recommendations as to the actions to be taken, the ways in which operational activities should be set up and their financing. The Report included proposals, sub-proposals and ca. 150 concrete examples. Important is also that the work of the national Delegation on Maths Education was reflected upon by a team of international experts in mathematics education making suggestions for improvements in Sweden based on their home expertise and experience from earlier visits to Sweden.

**The starting points or standpoints for the strategy for maths** focus clearly on meaningful maths for every citizen integrated in everyday life situation. Maths is not something to be separated from the whole **life context** but has to be linked to and embedded **in every life situation**. Constant reference is thus made in the operational activities to the link between maths, sciences, arts & culture including music and dance, cultural heritage, sports, history, geography, language and as many subjects as possible of the curriculum. Maths is also seen in a **lifelong learning and continuous learning approach** from the pre-primary school to adult education initiatives. Children should be confronted with maths in a creative way from their early age onwards.

Another key starting point is the **key role teachers / teacher educators** play in promoting maths and the vision that initial and in-service training requires particular attention. Furthermore a strong focus is put on **educational variation** taking into account that the talents and the learning style of every child have to be allowed to blossom (multiple intelligence). The **strengthening of cooperation, coordination and networking between all educational partners and stakeholders** is another clear starting point so as to enhance and strengthen a multiplier effect with particular focus on the dissemination of good practice and research.

The **Swedish Action Plan for Maths** is composed of **four key elements: to raise the awareness and interest for maths** at all levels using a variety of means and methods; **the training and education of qualified teachers for all students** through initial and in-service teacher education; **the support to teachers and schools** so as to be able to improve their teaching and learning; the continuous improvement of the focus on **aims, goals, contents and assessment** of maths education. Several actions and operational initiatives have been taken that have an impact on more than one of those four key elements. Some of the successful initiatives that existed before the Delegation's report were integrated in the Action Plan. An important element in the four key elements is that maths is seen as bridging elements to many other elements of the curriculum so as to contribute to education as a whole in the sense of 'Bildung'. Strong cross-fertilisation across the four key elements is an important issue.

**Raising interest** is done in various ways: Extensive information in NCM newsletters, journals and on the websites, The Kangourou competition, the Small Children's maths initiative, the hands-on maths initiatives with maths workshop areas in many schools, a book on the richness of mathematics as a pure and applied science, the cooperation between schools and science centres such as NAVET (a science centre with a specific department on maths education), the mentoring scheme of Chalmers University of Technology – INTIZE - involving students helping primary and secondary school children, the women in maths initiative are a selection of those presented to and discussed with the PLA participants.

**Working on qualified teachers in maths in initial and in-service teacher education** is happening through the restructured initial teacher education within which a high percentage of future teachers selects together with another subject also maths. Better

teachers is also achieved through special school-based in-service training activities such as the "Learning study" teams of maths teachers focusing on reflective action-research based teams of teachers in primary / secondary schools supported in their initial phase by the university. The national network of municipal supervisors of maths for the professional development and the in-set of teachers and the cooperation with the regional teacher development centres contribute also to more qualified teachers. Finally the biennial conferences, plus the journals and methodological tools and materials developed by NCM, the NCM resource centre and library and its websites contribute to better qualified teachers. Regular support to maths teachers to help them implement the action plan is largely done through the tools mentioned above concerning the training of qualified teachers.

**The constant reflection on the aims, goals, contents and the assessment is** enhanced by integrating the improvement of maths education into the whole school development process linked to the professional development of teachers individually and as teams. It is also promoted by the stress on the reflective teachers in a team context and by the strong focus on action-research based activities of the teachers. Furthermore major efforts are made in the Swedish and Nordic contexts to enhance research in maths education i.e. through the role of NoGSME, the Nordic Graduate School in Maths Education. In this way reflection and concrete actions are furthered in the area of the transition from upper secondary school to higher education and action is envisaged as to the transition from the lower secondary school to upper secondary school. The reflection was also strengthened by the input of and interaction with an international team of experts at the occasion of the drafting of the Delegation report and the subsequent action plan. Finally the constant reflection on goals, aims, contents and assessment – enhancing varied forms of assessment including integrated assessment- is also furthered through the **cooperation between the Ministry of Education, the National Agency for School Improvement, the National Agency for Education and NCM, the regional teacher development centres and the national network of municipal supervisors for maths education.**

**Success factors of a coherent strategy with a long lasting effect** were proposed as a conclusion. **The PLA enabled to present clearly the different elements and actions to implement the strategy for maths education set up subsequently to the report of the Maths Delegation** on the one hand. On the other hand **the PLA has also clarified the key elements for the long term success of such initiatives through the strong interactive discussions within the group of PLA participants.**

They agreed that the following **elements were important to set up and implement a successful strategy as to maths education:** a clear analysis of the situation of maths education, a comprehensive strategy plan with a long-term vision, Maths as a role in innovation, clear monitoring and follow-up of the implementation of the proposals by an expert coaching body such as the NCM in close cooperation with the ministry of education and other relevant bodies and stakeholders; the cross-fertilisation across the activities enhanced by the coordinating / coaching body NCM; focus on school development as a learning organisation, the key role and strong interaction between initial and in-service training focusing on classroom practice; the description and dissemination of good practice; the support through research and action research (reflective approach); supportive integrated assessment methods; the development of a strong network of experts at municipal, regional and national level open to European and international developments, the attention for and action in the area of gender in maths.

Key elements were also: the evaluation of the implementation of the activities within a total Quality Assurance system based on self evaluation; the constant interaction with all stakeholders especially the policy makers and finally adequate financial

support to support the different initiatives of the action plan plus the coordinating, monitoring and coaching role of NCM.

**This PLA on Maths education in Sweden has enabled to clarify the key elements of a focused action plan as to the promotion of maths education and it has enabled the participants to compare their initiatives with those of Sweden and get inspired by them.** The PLA has definitely proven to be an inspiring learning experience during which concrete arrangements have already been made between individual participants to further their cooperation and exchange in the field of improving maths education towards the immediate future. It also has to be stressed that over the two PLAs the group of experts has grown into a strong network of colleagues with many professional and personal links and contacts.

Special thanks was expressed by all participants both to DG EAC for its catalytic and synergetic role in the MST cluster and to the NCM, the National Centre for Mathematics Education for setting up this very useful PLA.



## **1. The MST cluster and the PLA or Peer Learning activity**

### **1.1. Role of the cluster**

As underlined in the Commission staff working paper supporting the 2006 Joint Report, 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. PLAs are a specific feature of the Open Method of Coordination under the Lisbon Strategy. 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 specific cluster on the 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.

This « MST Cluster » is composed of the following participants:

Cyprus – Denmark – France - Germany - Island – Latvia – Malta - Netherlands – Norway – Portugal - Slovakia – Sweden - United Kingdom.

### **1.2. The specific objectives of the MST cluster**

To follow up the European MST benchmark and to improve participation in MST studies and careers, especially regarding women (E&T 2010). Also to contribute to prepare scientific specialists for the Barcelona objective of reaching 3% of GDP in research. MST is one of the eight key competences for Lifelong Learning.

Priorities: modernise pedagogical methods; enhance professional profile of teachers; ensure transitions from secondary to tertiary; promote partnerships between schools, universities and industry; address the needs of special groups; improve female participation in MST studies and careers.

## **2. The implementation of the PLA on Maths in Göteborg**

It was already suggested at the first meeting of the cluster MST to organise a PLA in Sweden focusing on the topic of maths education as it was thought to be an important focus in the work of the cluster

General information about PLAs given above, is an extract from the background paper of the MST Cluster and PLAs of May 06

### **2.1. The preparation of the programme**

Following the Swedish proposal to host a PLA on maths education and the interest expressed by the members of the MST Cluster at the meeting of 4 May 06 in Brussels, the concrete preparations of the PLA started in November 2006. A first discussion had been held with Bengt Johansson of the NCM and with Max Kesselberg of the Ministry of Education and Research at the occasion of the Amsterdam PLA in November 2006.

The contents of the PLA on Maths was finalised at the meeting of the Cluster MST in Berlin on 18<sup>th</sup> April 2007.

Already in the Cluster meeting of 2006 it had been strongly suggested to organise PLA on maths education. It was thus agreed that the PLA would focus on all the stakeholders in the educational community that can contribute to enhance maths education: the ministry itself, the national agencies, the NCM, the national resource center in the field, the research institute in the field of Maths, the schools (teachers, heads etc.), the universities with initial teacher education, the in-service teacher training centres, other agents such as museums etc..

It has to be stressed that the PLA in Sweden proved to be extremely useful both for the organising country (SE) and for the participating countries (Cyprus, Denmark, France, Germany, Iceland, the Netherlands, Norway, Portugal) as are all in the process of developing and/or implementing a policy in the field of MST. It was strongly stressed that such PLA contribute greatly to innovative policy development and implementation.

The final programme added as an annex shows that the different elements that have to be in a PLA were indeed integrated. It was possible to implement the programme fully thanks to the perfect organisation of the NCM, the National Centre for Mathematics Education.

There was information about the Swedish education system. There were extensive presentations on the work done to analyse the situation of maths education through the activities and the report of the Delegation set up by the ministry of education and Research in Maths education. This linked up with the information about the action plan launched subsequent to the Delegation's report.

There were several sites visits: the first one Öjersö school in Partille to see how maths was being taught and how teachers – as a team – worked to improve the teaching and learning of maths by applying the Learning study methodology in cooperation with researchers. There was a visit to Chalmers University of Technology during which students were met involved in the Intize project. This project shows how students of Chalmers are trying to raise the interest for maths with pupils from the lower and upper secondary school so as to increase recruitment of minority students to higher education. A visit to a Science Centre “Nave” focused on how a science centre and a museum can contribute to raise the interest for maths education.

Extensive information was given about the different initiatives and activities set up or supported by the NCM many of them with financial support of the Swedish National Agency for School Improvement such as the Kangourou competition, the websites, small children's maths, the hands-on maths, the maths supervisors (ambassadors) at municipal level. All of them to raise the interest for maths with children and support teachers and school at municipal and regional level.

### **3. Introduction: Mathematics a key competence for active citizens**

Modern mathematical knowledge is multifaceted and covers theoretical knowledge as well as specific maths skills for many different purposes and aims. Insight and sound judgment are required regarding the role of maths in history, in contemporary society and culture, as a scientific language and theoretical modelling tool, and as a great human endeavour, kindred also with humanities and the fine arts.

To be a citizen in a modern complex democracy requires a lot more mathematical skills than shop floor counting and every day arithmetic. To understand and use different mathematical representation forms in political and economical argumentation, and to critically judge the nature of mathematical structures embedded in modern society is vital for an active citizenship. To design and implement a thorough and carefully prepared mathematics education program with high expectations and strong support for all is therefore crucial for an inclusive future education system.

Mathematics is often identified as the science of abstract patterns, and the problems posed by handling these patterns. Sometimes we extract patterns from the external world, both the physical, biological and sociological world, but also from the inner world of our own minds and thoughts. This process of concept abstraction has a long history with early contributions from many ancient cultures, and it has successively been underpinned and strengthened with an analogous development of an international mathematical symbolic language of high precision, efficiency and applicability.

The subject is rightly referred to as both the queen and the servant of science and technology, but also as a study of humanity itself. As a science of abstract patterns there is hardly no aspect of human culture that is not affected; patterns are the very essence of thought, language, society and life itself. Beyond the surface level of mathematical figures and symbols you will therefore find fascinating qualitative conceptions, such as the ideas of symmetry, change, structure, connection, chance, position and reasoning. For a profound grasping and understanding our world such basic conceptions seem to be essential both for the small child and for a variety of human enterprises in science, humanities and arts.

Proficiency in mathematics is today not mainly an affair about counting correctly, it is a multifarious general competence including problem solving and modelling, concept understanding, reasoning and communication, procedural efficiency, and appreciation of the role of mathematics in history, science, culture, work, and society. Education should not be restrictedly adjusted to an imagined fixed future scenario, this would indeed be in conflict with fundamental ideas of democracy, and also contra-productive. Our citizens are, and should be, the principal characters that form both societal and scientific future in collaborative and non-predictable creative action. A broad mathematical knowledge is in this aspect a part of a great cultural heritage, an heritage essential for both personal and societal self-esteem, creativity and growth.

**RECOMMENDATION OF THE EUROPEAN PARLIAMENT AND OF THE  
COUNCIL of 18 December 2006**

**On key competences for lifelong learning (2006/962/EC)\***

The European Reference Framework sets out eight key competences:

- 1) Communication in the mother tongue;
- 2) Communication in foreign languages;
- 3) Mathematical competence and basic competences in science and technology;**
- 4) Digital competence;
- 5) Learning to learn;
- 6) Social and civic competences;
- 7) Sense of initiative and entrepreneurship; and
- 8) Cultural awareness and expression.

**Mathematical competence**

**Definition:**

Mathematical competence is the ability to develop and apply mathematical thinking in order to solve a range of problems in everyday situations. Building on a sound mastery of numeracy, the emphasis is on process and activity, as well as knowledge. Mathematical competence involves, to different degrees, the ability and willingness to use mathematical modes of thought (logical and spatial thinking) and presentation (formulas, models, constructs, graphs, charts).

**Essential knowledge, skills and attitudes related to the competence:**

Necessary **knowledge** in mathematics includes a sound knowledge of numbers, measures and structures, basic operations and basic mathematical presentations, an understanding of mathematical terms and concepts, and of the questions to which mathematics can offer answers.

An individual should have the **skills** to apply basic mathematical principles and processes in everyday contexts at home and work, and to follow and assess chains of arguments. They should be able to reason mathematically, understand mathematical proof and communicate in mathematical language, and to use appropriate aids.

A positive **attitude** in mathematics is based on the respect of truth and willingness to look for reasons and to assess their validity.

\* OJ L 394, 30.12.2006,

[http://eur-lex.europa.eu/LexUriServ/site/en/oj/2006/l\\_394/l\\_39420061230en00100018.pdf](http://eur-lex.europa.eu/LexUriServ/site/en/oj/2006/l_394/l_39420061230en00100018.pdf)

[http://ec.europa.eu/education/policies/2010/doc/keyrec\\_en.pdf](http://ec.europa.eu/education/policies/2010/doc/keyrec_en.pdf)

#### **4. Key issues addressed during the PLA on Maths Education**

The structure of the present reports follows the logical structure of the PLA, the Peer Learning Activity. First the Swedish education system was presented and within this system the specific place for maths education. Secondly the Maths Delegation and its report were introduced to the participants as this report was the analysis of the present situation of maths education in Sweden which was the basis for the strategy subsequently outlined. The following parts focus on some of the different activities or initiatives to enhance maths education; some of those were successful initiatives that existed before the Delegation's report was drafted others are new initiatives subsequent to the approval of the report and the proposal of the Action Plan. Finally this report highlights some key conclusions and lessons learnt from this PLA.

##### **4.1. The Swedish education system**

*Full information about the Swedish education system is given in annex 1 to the present report. This short introduction just highlights some key elements.*

Sweden has a population of about 9.1 million people. There are 976.000 pupils in compulsory school (from 6 to 16) and 384.000 in upper secondary education (2006). 8% of the GDP is invested in education! There is a Minister for Education and Research, Lars Leijonborg and a Minister for schools, Jan Björklund. Several agencies assist the Ministry of Education and Research such as the Swedish National Agency for School Improvement, The Swedish National Agency for Education and the National Agency for Special Education.

Key words of the Swedish school system are: equal access, management by objectives, funded by taxes, no fees for tuition, an integrated school system and strongly decentralised. The Swedish education system is a decentralised system within which the 290 municipalities have the responsibility for education. They employ the teachers. The Swedish Ministry of Education and Research sets the standards to be achieved with the National curriculum. The schools are audited every 6 years to see if the standards have been achieved.

The last major reform was in the beginning of the 1990ties to turn the Swedish school system into a goal-based system with a high degree of local responsibility. The objectives of the reform were: to raise the standard of education, to adapt vocational education to the broad general skills requirements of modern working life, to create opportunities for lifelong learning, to minimise the risk of dead ends and to create an upper secondary school for all young people.

The upper secondary school mathematics in Sweden are divided into five courses from A to E. As there are problems with the success rate in mathematics (cf also PISA 2003 results), the interest for maths with children, the quality of the teaching and the learning of maths, not enough girls interested in higher studies with maths etc. The ministry decided to set up in the Spring of 2003 the Delegation to look into the problems and come up with suggestions for improving maths teaching and learning and to raise interest for maths in 2004.

General problems in schools education are the following at the moment in Sweden:

- Too many students in vocational programmes are leaving upper secondary school without a complete set of grades and thus without the leaving certificate;
- Students are not well enough prepared for working life;

- The studies the students did (based on their selection of modules in the upper secondary school) were too fragmented and should thus be more integrated;
- The students do not choose programmes that lead to areas where there are new professional opportunities;
- The school lacks contacts with the labour market and the social partners.

As there are specific problems as to the interest for natural sciences and technology (NT) also, the government has launched specific initiatives in that particular field of which are just mentioned but not expanded upon in detail.

NT subjects have more time in schools.

Technology has become a compulsory subject in compulsory school.

General science together with maths, are core subjects in USE and a natural science perspective is introduced in USE.

A special project in NT was launched from 2003 to 2005.

Unemployed engineers were retrained to teachers (2002-2003).

Special study grants were made available to have more NT students in Higher Education.

The Nordlab project (a Joint Nordic project) ran from 1999 to 2004.

Further in-set of NT teachers was strengthened.

An NT year was introduced in adult education or in H.Ed.

National centres for supporting NT (next Maths) were set up

Special financial support was given to science centres.

A maths Delegation was set up with a clear assignment in 2003.

NordLab - a Nordic laboratory for good teaching practice  
The Ministry of Education holds the presidency of the Danish part of the NordLab-project, which is a follow-up to a conference held in the autumn of 1997 in Bergen under the auspices of the Nordic Council of Ministers on mathematics, technology and science. The presidency aims at giving teachers of mathematics, science and technology tools and inspiration for innovating their teaching. The target group is teachers in basic schools, in general upper secondary education as well as teacher trainers and teachers in in-service training programmes.

## **4.2. The Maths Delegation: its report and the action plan**

### **4.2.1. The analysis of the situation of maths education**

The starting point for a special strategy to improve the learning and teaching of maths was the Delegation and its report. Results of the national assessments (NUO3), of PISA and of TIMSS studies had shown that the learning and teaching as to maths raised concern in Sweden and hence it was decided to analyse in depth the situation as to the learning and teaching of Maths. To make this analysis the Ministry of Education and Research decided to set up a Delegation in the spring 2003 to analyse the present situation and to come up with a action plan with concrete proposals to increase the interest in and motivation for maths education across Sweden. Within the Delegation seven working groups were set up of people with recognised skills in Maths education. Five of those groups focused on the different levels of education from pre-primary, to primary / lower secondary, upper-secondary, university and adult education. Two groups focused on transversal issues: maths and democracy and teacher education. The Delegation was invited up from the beginning to involve all the stakeholders ( ministry, agencies, universities, university colleges, social partners, schools, teacher training centres, companies etc.) in the process of the

analysis and the drafting of the action plan. It was a true bottom-up process involving all those involved in maths also at grassroots level.

The work of the Delegation coincided with other activities such a website on which all teachers and teacher trainers involved in the teaching and learning of maths could express themselves, make suggestions and comments. This website was thus used for open communication with and information to all those concerned with maths education. Several special conferences, seminars and workshops were run focusing on the assignment of the Delegation. The biennials organised for maths teachers and educators was also a forum for discussion. Large publicity was given to the activities of the Delegation and its experts.

One of the other activities was the organisation of a conference with international researchers familiar with Swedish mathematics education from earlier visits asking them to reflect on the Swedish situation and to come up with proposals for improvement. This enabled foreign experts to look critically at maths education in Sweden and compare to the initiatives to promote maths in their respective countries. Next to this visits were organised to the Freudenthal institute in the Netherlands, key experts and stakeholders in Finland and the French Ministry of Education.

All of those activities facilitated the reaching of a consensus at the end of the work of the Delegation. The report of the Delegation was available in 2004 and was the concrete starting point of a strategy to improve learning and teaching of maths. The reactions to the Delegation's report were positive and both the former government and the new government have taken the proposals as theirs in all important aspects for the coming years.

#### **4.2.2. General standpoints**

The Delegation started its activities by formulating some general standpoints that would be the basis for its work:

- Maths education should not be seen on its own but in relation to the whole curriculum and educational process. Maths has to be perceived as a key contribution to education of the whole personality or to 'Bildung'.
- Maths has to be meaningful for everyone and has to contribute to the education of democratic citizens. Special attention has to be given the early encounter of children with maths.
- To improve maths education, investment has to be made in teachers and teacher education. The role of teachers has to be highlighted and stressed.
- Educational variation (Cf. contents) has to be encouraged taking into account the various learning styles and intelligences of the children.
- Cooperation between all educational partners and stakeholders in the field of maths has to be strengthened.
- The role of maths and its significance in society and in life has to be heightened.
- Efforts have to be made to support and coordinate all innovative initiatives as to maths education.
- Major focus has to be given to research and networking of those involved in maths learning and teaching and in the dissemination of good practice.

The Report of the Delegation resulted in a series of concrete proposals. **There were 4 main proposals, 18 sub proposals and those then into 150 concrete activities.**



## Enhancing the status of mathematics



Everyone, from pre-school children to university and PhD students, enjoys the challenge and the sense of growing self-esteem in pursuing his/her mathematical thinking. For this to be possible, we need to utilize and support the commitment of teachers and provide real opportunities for skills development and good professional performance. Successful practice examples and professional pride, linked to sound subject knowledge, up-to-date research and classroom experience, help enhance the status of mathematics.

*The Swedish mathematic delegation*

### 4.3. The action plan for maths with four key proposals

The four key proposals suggested by the Maths Delegation report, were the following ones:

1. 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.
2. Train qualified teachers in maths on all levels for all children, young people and adults.
3. Support teachers and coordinate all the positive forces promoting better maths learning and teaching.
4. Clarify and develop aims, goals, content and assessment in maths for the entire education system.

The action plan can be said to be the detailed description of the four proposals plus the sub proposals and the concrete activities scheduled at the level of each of those proposals. As mentioned before the action plan took on board successful initiatives that existed before the Delegation's report and the action Plan were drafted.

Within these four proposals the following concrete suggestions were included which have not all been implemented yet. Some of those that existed before the Delegation's report and some that have been implemented so far have been focused upon during the PLA in Göteborg.

#### 4.3.1. Increase interest

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 Kangourou competition further as to contribute to make maths more fun for children (see information about the Kangourou 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
- A soap (on TV) on maths was considered (cf. We all use math every day!)
- 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

#### **4.3.2. Qualified teachers**

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 at Öjersö school in Partille municipality.
- More research on the topic.

#### **4.3.3. Support to teachers and schools**

Support teachers and coordinate all the positive forces promoting better maths learning and teaching.

- Spread information about innovative maths teaching and learning through website, blogs, examples of good practice (Cf. Nämnare, 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 biennials
- The organisation and development of the municipal network of math developers or ambassadors.
- More research on this topic.

#### **4.3.4. Aims, goals, content, assessment**

Clarify and develop aims, goals, content and assessment in maths for the entire education system.

- 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 some of the four proposals.

#### 4.4. Overview of the different activities or initiatives presented at the PLA

This table mentions the different activities and initiatives presented to and discussed with the PLA participants. They are described in chronological order so as to respect the programme outlined in annex 2. Some may fit in more than one of the boxes!

<b>Four pillars of the action plan</b>	<b>Activities presented during the PLA at NCM in Göteborg</b>
<b>Increase interest for maths</b>	The Kangourou competition The Navet (HUB) science Centre The journals such as Nämnaren, Normat The INTIZE initiative of engineering students of Chalmers University of Technology
<b>Qualified teachers</b>	The Learning study The focus on the subject to be taught in initial teacher education
<b>Support to teachers</b>	The Biennial conferences, the biennettes, The journal Nämnaren Conferences and courses supported or organised by NCM The maths supervisors The hands-on maths workshops The NCM website The NCM reference library Exhibition of teaching materials at NCM Network for collaboration in maths Workshops in Maths Books and reports Assignments for competence development NCM National reference library
<b>Aims, goals, content assessments</b>	Strävorna (Aims to strive for) Midsummer maths education conference The project in pre-school maths for teachers and children 1 to 5 yrs old The project on transition from upper secondary school to university Research activities carried out by NCM and NoGSME Research Journal NOMAD Investigatory and development work Coordination and cooperation Gender and maths

#### 4.5. The Learning study

The learning study is a way to contribute to professional development of teachers in a team approach within a school.

During a visit to the Öjersö school in the Municipality of Partille, the participants had the opportunity to meet a team of teachers involved in **school-based in-service training for maths using the Learning Study**. This is happening in cooperation with the university which has supervised and monitored the initiative in its initial phase. The information about the Learning study is taken from an article by Ference Marton and Lo Mun Ling "The Learning Study"<sup>1</sup>

This Learning study initiative is one of the element to be integrated into the proposal of the Delegation as to the improvement of the quality of the teachers of maths through in-service training, in this specific case through school-based in-service training.

##### 4.5.1. What is it?

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.

The point of departure is that teaching is –or should be– a rational activity. In planning a lesson or a unit, the teacher must take into account the characteristics of the students (e.g., age, general ability) as well as the physical conditions of the classroom (e.g., class size, equipment available).

However, all these concerns must be translated into actions that can help her to achieve specific goals, that is, the explicit capabilities that students are expected to develop. These capabilities are called the "objects of learning". Even in the most open classroom students' learning should not be accidental, but should be the result of conscious attempts on the part of the teacher to bring about the intended learning outcomes. In other words, attention must be paid to the ways in which the objects of learning are dealt with and enacted in the classroom.

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.

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<sup>1</sup> The full article about the Learning Study is to be found on the following website:  
[http://www.educ.umu.se/presentation/publikationer/lof/lofu\\_nr1\\_2007](http://www.educ.umu.se/presentation/publikationer/lof/lofu_nr1_2007)

The "learning study" differs from the Japanese lesson study model in that our research lessons are based on a theoretical framework of learning, namely, phenomenography (cf. Marton and Booth, 1997), and variation theory (see Marton & Tsui, 2004). In this way the learning study is a learning study not in two, but in three senses, as the researchers are supposed to learn from it as well (in addition to the students and the teachers).

#### **4.5.2. The cycle of the learning study**

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.

The kind of learning interested in is learning that enables the learners to deal with novel situations in more powerful ways than they would have been able to do without that learning.

Participants to the PLA had the opportunity to listen to the team of teachers involved in the learning study experiment and to discuss with them their experience.

## **4.6. The INTIZE initiative**

### **Engineering students mentoring secondary school pupils**

#### **4.6.1. What is it all about?**

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 junior high school all the way through to high school. The need is particularly great for this diverse body of students, as the majority of them come from underprivileged areas of Göteborg - in particular, Gunnared - where there is often a lack of resources and prevalent social problems. Every week, more than 250 high school students travel to Chalmers to meet their mentors. Every mentor is responsible for four high school students. High school students in their second year also receive the opportunity to tutor the junior high school students.

The students of Chalmers go to the schools and with the approval of the head of the school and the teachers, invite the pupils of the upper secondary school to come to the university during the weekend. When they come they do not only organise help and tuition but also sports activities. During soccer matches the pupils have the opportunity to meet other players from companies such as engineers, marketeers etc. During the games there is thus also an indirect opportunity to motivate young people for future work in a company. The contacts with people from company are in this way also organised in a very natural and unconventional way.

Mathematics is often misunderstood and dreaded among students; the numerous myths about math can prevent students from succeeding in or even enjoying the subject. Intize's mentors help break these myths 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.

Collaborators are primarily asked to give their time and share their enthusiasm and experience with others. Students recruit organizations and valuable contributors from different parts of society in order to find new ways to make this a valuable experience for all those involved. The project is entirely student-run. It proves to increase the interest of those children from those suburbs for maths, to attract more of those children to higher education and it has a positive effect on cooperation between different neighbourhoods. It thus contributes to active citizenship and to social inclusion.

#### **4.6.2. The success factors of the initiative:**

- 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
- There is a core group of students in charge of the management and the administration of the INTIZE project

- Change the natural environment of the mentee by bringing the children to the university
- The students act as natural role models and are accepted as such
- A high percentage of a class or school should be involved in the project; if possible up to 90% should attend the events
- The combination of mentoring activities linked to sports activities
- Sports activities in which youngsters are also meeting representatives of companies to stimulate them towards their future profession and the choice of a profession; indirect guidance
- The regular evaluation of the activities in the framework of the INTIZE project.

#### **4.6.3. Effects of the initiative**

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

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

It has to be mentioned that Chalmers' University of Technology has develop an optional course of "Social or societal entrepreneurship" (of 5 ECTS credits) which a student can take as part of this normal curriculum.

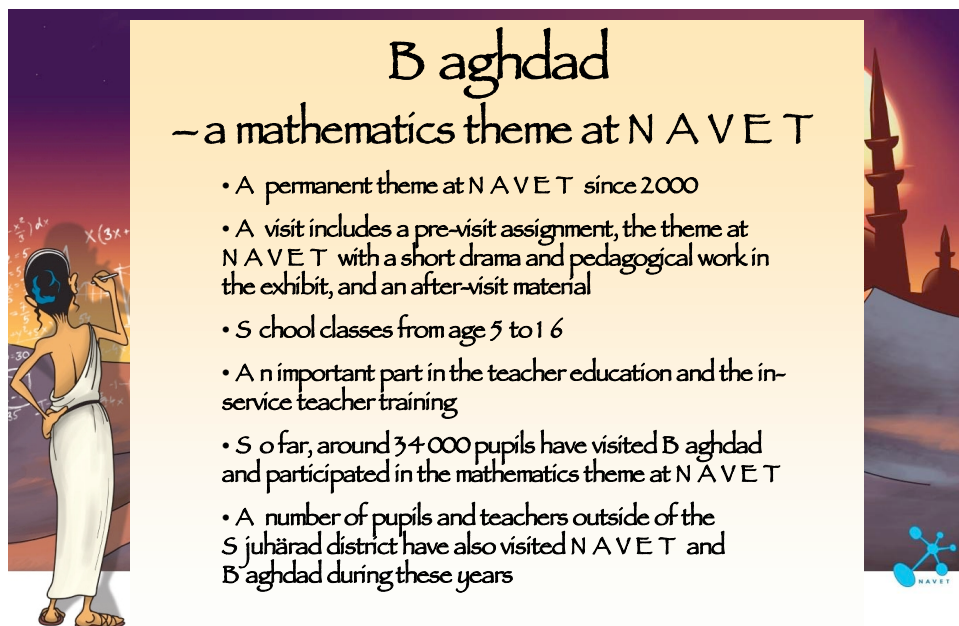
It would also be good if the involvement of university students in such mentoring activities would be explicitly mentioned on the Diploma supplement the student gets with his Diploma.

#### 4.7. 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 Borås, and with in-service teacher training centres. NAVET also has a travelling exhibition that can go to schools.



### Baghdad

– a mathematics theme at NAVET

- A permanent theme at NAVET since 2000
- A visit includes a pre-visit assignment, the theme at NAVET with a short drama and pedagogical work in the exhibit, and an after-visit material
- School classes from age 5 to 16
- An important part in the teacher education and the in-service teacher training
- So far, around 34 000 pupils have visited Baghdad and participated in the mathematics theme at NAVET
- A number of pupils and teachers outside of the Sjuhärads district have also visited NAVET and Baghdad during these years

All the activities in the centre, either it in relation with maths or other sciences, are organised in such a way that they stimulate the interest and the creativity of the youngsters that come to the science centre.



#### 4.8. 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 is one of a number of centres for different school subjects established by the government over the last 10 years. Recently a centre was also established for languages, development of reading and writing skills. In contrast to this centre, NCM does not come under the auspices of any state authority, but is an independent body at Göteborg University and runs its operations in conjunction with Chalmers University of Technology.

The following is a short summary of our current activities as presented during the PLA . Information on resources and different activities can be accessed on the central website of the NCM.

##### 4.8.1. The NCM website: <http://ncm.gu.se>

The aim is to make this web site a rich and 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. The ambition is to progressively build up, develop and maintain a resource page of high standard for mathematics educators and for teachers interested in developmental work and research in and around the subject of mathematics didactics.

Teachers find on the Nämnare website a great variety of downloadable materials that contain examples of problem solving exercises, Kangourou follow-up and hands-on activities to be used with pupils of different ages.

##### **Aktuellt (What's new).**

Information on questions of direct or indirect interest in the teaching of mathematics, its conditions and development is regularly provided on NCM's web site under the heading **Aktuellt (News)**.

NCM monitors and reports on debates and discussion in the media and about research and development work and initiatives, at local, national and international levels. Advisory services and development support NCM provides advisory and development support for teachers, schools and municipalities. NCM often receives requests for teaching material and for persons who could contribute to different conferences and development projects - most often via the Web.

##### **Kollegieblocket.se**

School heads and developers of mathematics in municipalities are increasingly visiting NCM to discuss planned development measures. At **Kollegieblocket.se (Notebook)** – a place of inspiration for teachers of mathematics – NCM gathers information from development work around the country. This work has been categorised and can be quickly accessed. The material contains short descriptions and contact information. The ideas can cover everything from concrete approaches ideas for the classroom to development work throughout the municipality.

#### 4.8.2. Journals

A very important part of NCM's work is the journal *Nämnaren* (Denominator) and the related series of books *Nämnaren TEMA* with titles such as *Uppslagsboken* (Book of Ideas), *Matematik i förskolan* (Mathematics in Preschool) and *Algebra för alla* (Algebra for all). The editorial board of *Nämnaren* is also responsible for the Kangaroo competition together with Kungl. Vetenskapsakademien (Royal Swedish Academy of Sciences). **Nämnaren can be considered to be 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.

One a year with this journal a **Maths Advents calendar** is made available with maths problems to be solved to stimulate interest of children and parents.

#### Strävorna

**Strävorna** is a part of *Nämnaren* on the net where are published proposals for pupil activities and articles arranged by "goals to aim for" that are laid down in the national syllabuses on mathematics. "Strävorna" contains a matrix describing the main goals and aims of maths education in the Swedish curriculum to reach those aims and goals.

The NCM also publishes the mathematics journal *Normat (Journal of Nordic Mathematics)* in conjunction with the society of mathematicians in the Nordic area and Institut Mittag-Leffler, in addition to the **research journal NOMAD** (Nordic Studies in Mathematics Education) together with Nordic research networks in mathematics education. Both journals have separate sections on the web site containing information on current contents etc. The latest issue of *Normat* contains i.a. an article that examines the arguments put forward by the anti-Darwinists from a mathematics perspective. The most recent issue of *NOMAD* contains an article on how mental arithmetic can play an expanding role in teaching.

#### 4.8.3. Books and reports

In addition to these three journals and *Nämnaren-TEMA*, the NCM publishes reports, reviews of research and support material. Some of its new publications are the books *Matematikverkstad* (Mathematics Workshop) and *Små barns matematik* (Mathematics for Small Children) which together with *Nämnaren TEMA Matematik i förskolan* (Mathematics in the Preschool) are the result of a nationwide pilot project for children 1-5 years and their teachers. A recent addition is the book *Lära och undervisa matematik – internationella perspektiv* (International Perspectives on Learning and Teaching Mathematics). It contains translations of articles and revised versions of a number of articles previously published in the NCM book *International Perspectives on Learning and Teaching Mathematics*. Amongst the other titles, the following can be mentioned *Familjematematik* (Mathematics for the Family) and *Läs- och skrivsvårigheter och lärande i matematik* (Reading and Writing Difficulties and Learning in Mathematics).

#### 4.8.4. The Kangourou competition

The NCM runs the Kangaroo competition to promote maths. This game-contest the "Kangourou des Mathématiques" was created in 1991 in France by André Deledicq, based on the "Australian Mathematics Competition". It aims to promote the

spreading of a basic mathematical culture by all means and, in particular, by organising an annual game-contest to be held on the same day in all participating countries. The game intends to attract the maximum number of pupils without aiming at any national selection nor a comparison between countries.

**The contest:** It is composed of just one activity: no selection, no preliminary, no final test. The contest takes place in March, on the same day and the same hour in all countries and consists in a Multiple Choice Questionnaire of twenty-four or thirty questions of increasing difficulty. For each question a choice of five answers is provided. 5 subjects are proposed, Primary Schools (8-10 years old), Benjamins (11-12 years old), Cadets (13-14 years old), Juniors (15-17 years old), Seniors (18-19 years old). The classifications are different according to class level (for example, in France, 6th grade and 7th grade for Benjamins) and/or options of schooling (vocational school, scientific majors, etc...)

The Swedish Kangaroo: 5 subjects are proposed, Ecolier (school year 3 and 4), Benjamin (5-7), Cadet (8-9), GyCadet (Corse A at "gymnasium") Junior (course B and C), Senior (course D and E).

The emphasis is put on the follow-up of the competition, which is considered to be the starting point only. Since the problems of the competition are quite difficult but also rich mathematically, there are great opportunities to continue to work with the problems in the classroom. Support material for this is issued in connection with the competition. All the material is also available on the web site.

#### **4.8.5. Conferences and courses supported or organised by NCM**

##### **4.8.5.1. Biennial maths conferences**

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 around the country. These biennials are arenas where teachers can meet, discuss, exchange ideas and good practice and also meet and listen to researchers. It is considered to be the most important and the biggest event in the maths teachers professional development career. In between the large Biennials for maths involving 3500 to 5000 teachers smaller biennettes are held at regional level. This means that every two years some 6000 to 7000 maths teachers are reached with those in-service training conferences. Pre-conferences on research in mathematics education are also organized at every biennial by the SMDF, Swedish Society for Research in Mathematics Education (involving some 200 national and international participants).

The NCM takes part in a number of national, Nordic, European and international conferences and workshops on mathematics education. The Centre also participates in major school exhibitions during the autumn in Göteborg, Malmö and Stockholm. At Skolforum in Stockholm, NCM leads the planning and implementation of exhibitions, mathematics workshops and lectures in a special section on mathematics, Mattetorget (The Maths Square). Information on current national, Nordic and international conferences is provided on the NCM website.

##### **4.8.5.2. Midsummer Maths education conference 2003**

Linked to the activities of the Maths Delegation and the drafting of the report with proposals to improve maths education, NCM organised a major conference with leading experts from around the world in the area of maths education.

Each of the participants was invited to address one of the themes concerned the Maths Delegation. Each had to draft a brief research paper and make suggestions and recommendations to improve maths education in Sweden based on their own

experience. The contributions were edited and published in the NCM book *International Perspectives on Learning and Teaching Mathematics* (600 pages.) and in a Swedish version with a selection of articles. All of this material could be used in the action plan drafted subsequent to the report of the Delegation.

#### **4.8. 6. Adult learning**

NCM's assignment from the government also covers initiatives for adults learning mathematics. On the web site, NCM provides information about the organisation of adult education, the players, steering documents and resources and about our cooperation with the City of Stockholm and Linköping University over courses in mathematics education. The work focuses on adults' learning of mathematics at the compulsory and upper secondary school levels in municipal adult education and in liberal arts education organisations. NCM also has great interest in learning that takes place in other environments, e.g. at the workplace. NCM is also involved in the EMMA project of Grundtvig 4 in the framework of the Socrates programme.

##### **The EMMA project: European network for Motivational Mathematics for Adults**

The purpose of this project is to create a sustainable and ever increasing network of experts in research, need analysis, didactic approach development, motivational aspects, and content creation related to the learning processes involved in adults learning Mathematics.

The EMMA Network – a Grundtvig 4 Network - intends to pay attention to difficulties with numeracy. This is the knowledge and skills required to effectively manage and respond to the mathematical demands of diverse situations. Even in countries with a high level of awareness about this issue, we find that education and training providers are often at a loss to find adequate strategies, approaches and didactical methods that will help adults, at individual level or as employees, reach a higher level of numeracy.

European researchers, experts and policy makers need to network to be able to raise awareness of the scope of the problem and of possible remedial strategy, to exchange research results, experiences about good practices, and new didactic approaches and to discuss new recommendations that can be implemented by policy makers.

The activities of the project have mainly consisted so far in the organisation of study-visits to the partner countries. 17 countries are involved plus to associate countries Viz. Australia and Switzerland.

#### **4.8.7. Assignments for competence development**

To the extent that time permits, NCM also undertakes assignments if they are part of planned long-term development measures in schools and municipalities. One example is the participation in the mathematics initiative for the City of Stockholm. NCM shares its experiences through its website, in journals, literature, conferences and advisory services.

#### **4.8.8. Network for collaboration in maths**

The NCM collaboration with the National Agency for School Improvement, universities, university colleges, the municipalities and individual schools is intense and developed continually.

NCM is also working at strengthening collaboration with and between the national network, organizations, associations, committees and those concerned with the environment who, for one reason or another, can contribute to the development of Swedish mathematics education e.g. The Biennial Council, The National Association

for Teachers in mathematics, natural sciences and technology - LMNT, The National Resource Centres for Science and Technology, The Network: Teacher Trainers in Mathematics, LUMA, The Network: Women and Mathematics, The Research Group for assessment of Knowledge and Competence at Teacher Training College in Stockholm – the PRIM-group, The Swedish Association for Mathematics Education Research - SMDF, The Swedish Association of Mathematics Teachers - SMaL, The Swedish Committee for Mathematics Education, SKM at the Royal Academy of Sciences (KVA), The Swedish Society for Mathematicians, The Swedish National Committee for Mathematics at KVA, The Swedish National Research School in Mathematics Education and The Unit for Pedagogical Measurement at Umeå University.

Discussions have started 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 origin from some of the members earlier work at the Nämnaren Project and at the section of mathematics education, department of didactics Göteborg University. Since 1985, a steady stream of international and Nordic guest lecturers have visited NCM. Many of those (more than 120) guests are distinguished members of the international community of mathematics education, leading the work of research and development in mathematics education around the world. NCM's work with the US curriculum project, the Standards of the National Council of Teachers of Mathematics, is a direct result of one of those contacts.

#### **4.8.9. Investigatory and development work**

As a result of assignments from the government and Swedish National Agency for School Improvement, NCM takes part in different national initiatives. For example, the office of the Mathematics Delegation was placed at NCM. The work of the Delegation resulted in a report that provides the foundation for a number of measures currently being implemented. Amongst the measures that NCM takes part in can be mentioned support to local supervisors of mathematics education, authoring of teacher material for inservice training, support and guidance. The government's diversity initiative, the transition from upper secondary school to higher education.

#### **4.8.10. National reference library**

NCM's reference library on the literature of mathematics education contains more than 5 000 volumes and 80 journals. On the web site, there is a resource section where interested people can search for literature. Information is also provided on a regular basis about new acquisitions and journals with brief descriptions of the content of current articles.

### **Exhibition of teaching materials at NCM's library**

The exhibition covers current Swedish textbooks and teaching materials for mathematics and related support material- for example, instruction guides for teachers, games and puzzles -- covering preschool to upper secondary school and adult education. Publishers present their teaching materials and update the contents regularly. The exhibition is well worth a visit if one is considering the adoption of new teaching materials.

### **4.8.11. Workshops on mathematics**

NCM's *Workshops on Mathematics* are a meeting forum for everyone interested in "hands on", innovative and experimental ways of working in the teaching of mathematics. As a result of numerous requests from teachers wanting to build a mathematics workshop in their own school, a manual has been put together for mathematics workshops, related study circle instruction material with substantial resources on the web to support this. As a result, more workshops on mathematics have been built up at schools around the country. More and more groups of teachers are visiting the workshops.

### **4.8.12. Project activities of the NCM**

Amongst current projects at NCM can be mentioned mathematics terminology in school, the treasures /richness of mathematics research and diagnostic material for numbers and arithmetical operations, grade 1-9. One recently started project is *Kardborreprojektet* (Burdock Project) - an assignment from the Swedish National Agency for School Improvement - where NCM in conjunction with national resource centres in biology and biotechnology, physics, chemistry and technology have been commissioned to develop support material on how teaching in mathematics can contribute to better goal attainment in these subjects, how these subjects can enrich mathematics.

#### **4.8.12.1. Pilot project in pre-school maths (1-5 years old)**

NCM is involved in an innovative pilot project to promote maths in pre-school  
*The overall Goals to strive towards with this project (Mathematics, Lpfö 98, pp. 12-13)are the following ones:*

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* was 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 was 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 were 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 every day situations. By working in this way maths education was very often combined with other areas such as cultural heritage education.

*The activities within the project.* 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.

#### **4.8.12.2. Hand-on maths / Matematikverkstad**

The objective of a mathematics workshop is to create an environment within the school where the learning and teaching of maths is facilitated. Usually such a hand-on workshop is a classroom that is arranged and furnished 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 and 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 use 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).

There are reports (TIMSS, Pisa etc) that conclude bigger variation in the maths teaching. A maths workshop help teachers to plan and realize such 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. They know that 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. That

means it is important to do what is best in each place. Working in the textbook in the maths workshop isn't so wise or fruitful

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. Versions exist in and Norwegian so far! 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 also available to help schools that want to create within their schools a mathematics workshops.

A maths workshop is not The or the only way but it is one more way for the teacher to reach his goal and raise the awareness for maths. This kind of approach also has to be seen in the light of the variation theory as it is another and varied way to reach certain groups of youngsters with maths.

In such a maths workshop the pupils can be involved in all sorts of hand-on activities with maths (similarly to what pupils experience in a hands-on science activity within a school). During the maths workshop activities the pupil is involved in various activities ranging from talking , to writing, to making booklets etc. It is the ideal learning environment to promote creative maths learning.

#### **4.8.13. Municipal maths supervisors or Matematikutvecklare**

A national network and initiative for supervisors of maths in-service teacher education and school development at municipal level.

On behalf of the National Ministry of Education and Research and the National Agency for School Improvement it was decided as a contribution to the 3<sup>rd</sup> proposal of the action plan - Support teachers and coordinate all the positive forces promoting better maths learning and teaching – to launch a network of municipal maths supervisors composed of experienced maths teachers. They are not inspectors but have to be seen more as pedagogical advisors for maths. The network is the responsibility of the municipalities that are in charge of the schools within their area. Sweden has indeed a strongly decentralised school system.

Thus a national network of municipal maths supervisors or maths ambassadors was created to support teachers of maths at local level. The ambassador 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.

The maths supervisors 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.

The supervisors 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.



NCM supports the supervisors in the following ways: 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 examples of how to plan, implement and evaluate development work; It contributes to create and develop networks on a local, regional and national level.

The conferences organised to train the supervisors are composed of different elements. Lectures on topics such as : What is mathematics? What is to know mathematics? Why shall we learn mathematics? Where can you find mathematics? Researchers come to the conferences and talk about their research. Information is given about the Learning study. Information is given about National tests in maths compared with teacher's own tests in maths. How to work with pupils with other languages than Swedish. The role of the textbook in mathematics, didactics, assessment and mathematics in pre-school.

Next to the lectures there are group discussions on topics such as: What have teachers already done to improve maths education, what is the next step, what type of support do teachers need from NCM, from the municipality. Concrete example from development work in the municipalities are also given answering questions such as: How to plan, implement and evaluate development work. They will also liaise with regional network of in-service teacher education centres.

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. They have also been invited to the conferences to present how they can support 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.

#### **4.8.14. Transition from secondary school to higher education**

Another important aspect to enhance 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. The 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. In 2002 there was a report "Evaluation of undergraduate and postgraduate programmes in maths at the H.Ed. institutions, in 2003 there was the report "Evaluation of the undergraduate programmes in engineering and fire protection engineering at H.Ed. institutions" and in 2005 there was the report "Freshman maths: teaching maths in the 1<sup>st</sup> year programmes in technology and the natural sciences.

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.

**Websites and courses: [www.maths.se](http://www.maths.se) and [www.mattebron.se](http://www.mattebron.se)**

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](http://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, of course, mainly teachers from upper secondary schools, students in their final year of upper secondary school and lecturers from universities or university colleges. Information about the local meetings is to be found on the Mattebron website ([www.mattebron.se](http://www.mattebron.se)). The internet-based course 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 as experienced university students mentoring or tutoring secondary schools students (see to this effect the students of the Chalmers' university with the INTIZE initiative).

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 may be done in the future at the lower levels of the education system such as the transition from lower secondary to higher secondary schools.

**4.8.14. Research**

A number of the staff at NCM take part in different research projects. One example is Lars Mouwitz who recently defended his thesis at KTH on mathematics and general education. Another example is that of Jesper Boesen who in September presented his thesis at the University of Umeå on Assessing Mathematical Creativity.

**4.8.15. Coordination and cooperation**

As is evident from the descriptions above, NCM has extensive cooperation with various national and international organisations, associations, authorities, networks, environments, universities and university colleges.

**4.9. The reform of teacher education in Sweden 2001 – 2004****4.9.1. Most characteristic features**

The most characteristic features of this reform are the introduction of a core of general teacher skills: the general field of education on the one hand and on the other hand that teacher education is connected to research.

Reasons for the reform

The main reasons for the reform are the following: new school curricula had been brought in, the pre-schools had been given more pedagogical responsibilities, the

upper secondary schools had changed radically and the teachers must be able to take on a new role in society and in their teaching job.

#### Control of the Teacher Education in Sweden

Control of teacher education in Sweden is characterised by partially limited autonomy on the one hand and by Guiding documents regulating a minimum of hours, which subjects are required for a teacher's degree, specifying the distribution between studies in different subjects, the didactical parts and the practical parts of the education.

#### **4.9.2. The Teacher Programme**

The teacher education programme is between 180 – 330 ECTS credits and consists of the following elements:

- A general field of education (90 credits)
- An educational area with emphasis on a particular subject or subject areas (at least 60 credits)
- A specialized educational area (at least 30 credits)
- Degree thesis (worth 15 credits)

Students with subject qualification can study simply the general field of education

The general field of education consists of areas of knowledge that "are central to the teaching profession": teaching, special needs education, , child and youth development, interdisciplinary subject studies, empower future teachers to 'teach citizenship' .

Gender equality issues are included in the general field of education and special attention is given to this during the practical part of the education.

An educational area with emphasis on a particular subject or subject areas comprises at least 60 credits. At least 15 of them should be tied to practical experience in schools. This area must be appropriate for the age that the future teachers are going to teach and the subjects they specialize in.

A specialized educational area that comprises at least 30 credits. This area is intended to deepen and broaden the student's previously achieved knowledge

#### A specific initiative related to teacher education

The Ministry of Education and Research has launched a three year in-service training programme beginning in Spring 2008 focusing on improving the learning and teaching of Swedish as a first priority and improving the learning and teaching of maths as a second priority, due to the wish from the municipalities. This in-service training programme is organized by Swedish National Agency for Education,

**2,7 billion** Skr will be made available to municipalities and to universities to run various in-service courses (of 15 - 30 credits), altogether for all school levels and subjects. This in-service training programme will largely have the potential to contribute to the implementation of the second proposal of the Action Plan to have more qualified teachers.

#### 4.9.3. Other elements

##### Requirements

For teaching in pre-schools, pre-school classes and the first years of the compulsory school: 210 credits. For teaching at higher levels of compulsory schools and upper secondary schools: 270 credits. For teaching at upper secondary school vocational programme: 180 credits

##### The 'special body'

All universities and university colleges who offer teacher education have a 'special body' that has overall responsibility for the undergraduate programme, for research and for postgraduate studies linked to teacher education.

##### The link to research

A characteristic of the new teacher education system is the stronger link with research at all levels. Therefore, the number of teacher trainers holding a PhD should be increased. The National Science Council has created a specific committee on educational science. The committee promotes research with direct relevance to the teaching profession. The objective is also to involve teachers in actions research initiatives such as the learning study applied in several Swedish schools.

Special needs education should be offered within the general field of education. It is possible to arrange special needs teaching both in the areas of emphasis and in the areas of specialisation. There is also an advanced special needs training programme that leads to a degree: 'special needs teacher'

Since schools should provide children with the ICT tool for "acquiring, processing and forming their own opinions", teachers' mastering of the ICT tool is seen an important aim for the teacher education.

#### 4.10. 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.

The aim of a Nordic Graduate School in mathematics education :

- To support and develop the education of researchers in mathematics education in the Nordic and Baltic countries,
- To create constructive cooperation in order to raise the scientific quality of research in mathematics education,
- To give all doctoral students in mathematics 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.

*The utmost aim is to create a network of cooperating partners, who can continue to collaborate 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 supervisors and exchange of experience;
- Partnership and collaboration with distinguished international scholars;
- Creating a database for ongoing work, theses and greater development work in mathematics education;
- Granting mobility stipends and special financial support for doctoral students.

Examples of courses that has been offered from 2004 :

- Theory of science from a mathematics education perspective;
- Meta-perspectives on mathematics and the learning of mathematics in a technological environment;
- History of mathematics with emphasis on modern mathematics;
- Theoretical aspects of mathematics education with emphasis on the French School Problem-solving;
- Theories of learning and teaching mathematics;
- Research design and research methods;
- Views of knowing and learning: Constructivism and socio-cultural theory;
- Gender and mathematics education.

Summer schools, seminars for supervisors and workshops

Annual summer schools are organised on various topics . Seminars for supervisors take place focusing on issues such as: Quality in research, Quality in theses, The supervision relations, Reviewing of papers, Research education programmes in maths education, Education of new supervisors, Reviewing of scientific papers and publication policies etc.

Workshops have focused on topics such as: Classroom research, Research on mathematics textbooks, Theoretical frameworks for research, use of ICT in

mathematics education, Research on mathematics and language, Justification in mathematics and science education research and the role of theory in the justification.

Cooperation with various partners and centres of excellence

NoGSME has a close cooperation with Nomad, Nordic Studies in Mathematics Education. Doctoral students and supervisors are invited to publish in Nomad . In each issue of Nomad a few pages are devoted to the NoGSME programme and activities.

NoGSME is cooperating with various international centres of excellence such as : the Institute of Advanced Study of La Trobe university, Concordia University, University of Michigan, University 7 Paris and the University of Klagenfurt, Didaktik der Mathematik.

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

The aims and the activities of the Nordic Graduate support indirectly or directly the action plan for maths education implemented in Sweden subsequent to the report drafted by the Delegation nominated by the Swedish Ministry of Education and Research.

#### 4.11. Gender and mathematics

A Network project to increase women's participation in mathematics

Women's performance in mathematics is good but women's participation is not satisfactory in Sweden. Change over time has been slow (Grevholm, 1996). In an effort to speed up the rate of change in the area of gender and mathematics a network "Women and mathematics" was created in 1990. The network that was created to increase women's participation in maths, builds on international and Swedish research results in mathematics education in its efforts to influence important parts of society, teachers and students.

Since the 1960ies many initiatives have been taken to recruit more girls to mathematics, science and technology. Such initiatives often create enthusiasm as long as they last but after their conclusion everything goes back to "normal" again.

The gender and mathematics situation seems to be similar in all developed countries. The network project has a research base for its work composed of an overview of earlier gender research is a foundation for the construction and analysis of the work of the network and a philosophy of critical mathematics education that serves as theoretical framework.

The network: an intervention project

Criteria for evaluating intervention projects have been used in the discussion of the effects of the network. The claim is that Women and mathematics Network is one possible efficient way to implement research results in order to create actions in mathematics teaching.

Research findings in the area of gender and mathematics (Fennema 1995 p 26, 1996) highlight the following elements:

1. *Gender differences in mathematics may be decreasing.*
2. *Gender differences in mathematics still exist in: learning of complex mathematics, personal beliefs in mathematics and in career choice that involves mathematics*
3. *Gender differences in mathematics vary: by socio-economic status and ethnicity, by school, by teacher*
4. *Teachers tend to structure their lessons to favour male learning.*
5. *Interventions can achieve equity in mathematics.*

Two major reviews of gender research (Leder, 1992, Leder, Forgasz & Solar, 1996) indicate the issues and concerns that have been in focus during the last three decades in the area of gender and mathematics.

Performance, participation, attitudes and beliefs, motivation, self-confidence, emotions, career choices are factors that have been studied.

The Swedish Network Women and mathematics

The aims of the network Women and mathematics in Sweden as stated in 1990 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 the international network 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

Criteria for assessing intervention programmes such as this Network

The following criteria are used to assess the achievement of primary goals of intervention programmes such as this network as measured by staff, participants or external evaluation:

- Length of time of the program's operation;
  - Ease in attracting outside support;
  - Ratio of applicants to participants (program popularity);
  - Reputation of program with scientists from relevant fields;
  - Program imitation or external expansion;
  - Cost effectiveness;
  - The strength of the academic content: and
  - The competence and orientation of teachers for programs with academic orientation
- (taken from Malcolm, 1984)

What have been achieved through the network?

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 to investigations and essays by students and teachers on gender issues.

Long-lasting intervention

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.

What the presentation cannot convey is the joy and satisfaction this work has created.

Future plans

All future activities depend on the initiatives and actions taken by women 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 in the network. The international Newsletter of IOWME is distributed regularly.



#### **4.12. The Swedish National Agency for School Improvement (MSU)**

Every pre-school, school and adult learning centre is expected to provide an environment that stimulates learning and development. The main purpose of the Swedish National Agency for School Improvement is to realise these ambitions. In Sweden the educational goals are expressed in three national curricula – one for pre-schools, one for compulsory schools and one for upper secondary schools – decided by the government.

The municipalities and their schools are responsible for finding ways of reaching the goals, evaluating the efforts and improving the work. The state supports the municipalities and their schools in their strivings to provide and develop the quality of the inner work. Two national agencies are the main actors here. The National Agency for Education controls and evaluates. The Swedish National Agency for School Improvement supports improvement work and plays a major role to promote and support innovation in education.

Responsibilities and duties of the National Agency for School Improvement:

- It is responsible for general support to schools within nationally prioritised areas such as maths
- It supports local development of work quality and improvement of learning environments
- It stimulates the development of professional competence among educators
- It is responsible for the national programme for school leader education
- It supports the widened use of ICT in education
- It disseminates knowledge, experiences and research among professional educators
- It participates in national and international networks that stimulate school improvement

The Agency for School Improvement cooperates with other actors, like municipalities, schools, universities and professional unions that are interested in the development of education. Flexibility and effectiveness, respect for local needs and circumstances as well as long-term commitment are hallmarks of the agency.

The Agency for school Improvement is actively involved in the development and the implementation of the municipal maths supervisors initiative mentioned earlier. It is also involved in promoting maths through the regional centres.

The Swedish National Agency for School Improvement plays a major role in the whole process of improvement maths education and learning. Together with the Ministry of Education and Research it has commissioned NCM to implement some of the activities of the Action Plan. It supports strongly the work of NCM and sees to it that the finances are available so that NCM can contribute to the implementation of the Action Plan.

It is also developing the webmaths initiative. Webmaths is an online resource for notes, exercises and tests and also a meeting place designed to help high school maths students work through and discuss their maths problems on the internet. Based upon the West Australian high school maths syllabus, Webmaths offers fundamental maths concepts, exercises and tests that apply to students all over the world. The resources available on this site are free for personal use and we hope that this site gives you a better understanding of mathematics

It also organises study-visits for key people abroad to get in touch with innovative developments in education. The Agency also develops dialogue guides for schools based on most recent national evaluations.

## **5. Success factors of a policy to promote maths education**

Subsequent to the presentations and the discussions the following elements can be said to be the key policy elements that contribute to the long-term success of activities promoting maths education. Several of the participants stressed that they would stress or were stressing elements in their policy as to the promotion of maths education. This means that the elements mentioned below can be said to be characteristics for a strong policy to promote maths education in other European countries.

### **5.1. A clear analysis of the situation as to maths education in Sweden**

Very important was considered to be the preparatory work done by the Maths Delegation. This Delegation was in charge of making a state of the art analysis of maths education in Sweden. It was thought to be crucial that all partners and stakeholders concerned by maths education had been actively involved in the drafting of the report. All those involved from the teachers at grassroots levels, to the universities, the ministries and companies, had been given the opportunity to give their opinion and make suggestions and proposals for improvement. This resulted in a report based on a large consensus both as to its contents and as to its proposals and the strategy to go forward. The open working method with clear and original standpoints up from the beginning also facilitated the work of the Delegation.

### **5.2. A comprehensive action plan with a long term vision**

Based upon the work of the maths Delegation an action plan was developed with clear objectives addressing all key issues and all key groups or stakeholders concerned. The action plan can be said to be comprehensive both horizontally and vertically. Vertically as it addressees all the levels of education from the pre-primary school to adult lifelong learning. Horizontally as it addresses all major stakeholders: the ministries, the municipalities, the teachers and heads of schools, the teacher trainers (both initial and in-service teacher education), the regional resource centres, the science centres, the ministry of education, the agencies such as the Swedish National Agency for Education and the Swedish National Agency for School Improvement, the universities, research, companies (to a limited extent!), NCM (with its various activities and support elements) and other national centre for physics, chemistry, biology etc. The involvement of university students is also an important element! Important is also the focus on key areas such as the transition from the upper secondary school to university. In the future focus will also be given to the transition from the compulsory school to the upper secondary school.

The fact that all those agents interact facilitates networking and cross-fertilisation and strengthens the implementation of the long-term action plan. The NCM plays a key role in the implementation which will be highlighted later on and which focuses on key support to be given to all those involved in the implementation of the action plan for maths. The NCM is indeed the central force that keeps motivating the different actors involved in the different activities to promote maths education.

One could say that the NCM is the spider at the middle of the horizontal and vertical elements that are linked to the implementation of the action plan for maths in Sweden.

### **5.3. Maths as a role for innovation**

It is quite remarkable that maths education can be seen as the motor or engine for innovation in education. Very often maths teachers are said to be less open to innovation in school education. However, the Swedish experiences in the framework

of the present action plan shows that maths teachers, supported by other key actors such as the universities, the university colleges and NCM, can become real change agents promoting innovation. It is remarkable that the maths teachers, alongside other teachers, play a key role in the promotion not only of maths education but of education as a whole as a contribution to educating active citizens.

#### **5.4. Monitoring, coordination of implementation of proposals**

The Delegation's report and the implementation of the maths Action Plan is pushed forward step by step by the Ministry of Education and Research through commissions to the Swedish National Agency for School Improvement, the National Agency for Education and the National Centre for Mathematics Education.

Although this role hasn't been explicitly assigned to the NCM, it appears very clearly that the NCM is playing a key role in the monitoring, the follow-up and the coordination of the different proposals to implement or valorise elements of the Action Plan for maths. It plays a role comparable to the role the Dutch Platform Bèta Techniek in the implementation of the Delta plan for science and technology which was the object of the November 2006 PLA visit in the Netherlands.

The whole team of the NCM seems to be very well aware of its role in supporting the implementation of the action plan. They clearly have the necessary expertise and experience to take on this responsibility. Indirectly (or even directly) they keep on driving forward the implementation of the action plan for maths in Sweden. It also appears that most stakeholders seem to accept that NCM plays this synergetic and catalytic role.

The lesson to be drawn from this is that it is important that a central body or organisation has to be put in charge of the implementation of the action plans decided by the Ministry of education and research and the government.

During the discussion regularly reference was made to the Dutch Platform Bèta Techniek in charge of the implementation of the Delta Plan for science and technology. This platform plays a key role in promoting innovation in maths, science and technology. It has the advantage of being an officially recognised and funded structure that can contribute in a flexible way to the implementation of strategies decided in the area of maths, science and technology. Some of the countries involved in the 2006 PLA in the Netherlands have been in contact with the Platform Bèta Techniek and have even visited it, to see how they can create a similar model in their country.

#### **5.5. Adequate financial support**

It is important that the implementation of a good and comprehensive long-term action plan is backed by long-term financial support. On the hand major funds have been made available to implement new or support existing actions to promote maths education. More funding is scheduled in the area of the in-service training of teachers that will results in many in-set activities up from spring 2008 to be organised by municipalities and universities. The contribution of NCM to the implementation of the action plan for maths seems to be pushed forward by regular, very often annual injections of funds, which require a long and tiring negotiation process by NCM.

The advantage of the Dutch Platform Bèta Techniek is that it is funded for a certain number of years with a clear assignments and that its achievements are evaluated or assessed in relation with the impact of its activities to support the action plan.

#### **5.6. Motivation and ownership of individual schools, teachers and heads**

All stakeholders and especially the teachers, the head of schools have been given the opportunity to air their views and make suggestions during the process of the drafting of the Delegation's report. This resulted, as mentioned before, into a broad support given to both the standpoints and the action plan with proposals, sub proposals and concrete activities proposed in it. It also resulted in a broad ownership of the innovations set up. However, it appears that schools and municipalities that choose to be involved in the implementation of the action plan do so without any clear contractual commitment to the math supervisors (ambassadors). In the Netherlands the schools that choose to be involved in the activities of the Delta Plan for science and technology accept a contractual obligation to reach certain objectives if they are given financial and monitoring support. In Sweden the innovation is driven forward by the motivation, the ownership and interest of schools, heads and teachers.

### **5.7. The evaluation of the implementation**

There is no large scale evaluation of the action plan which is scheduled at the moment by the Swedish Ministry of Education and Research and by the Swedish National Agency for School Improvement. Separate actions and initiatives implemented within the action plan seem to be evaluated by the beneficiaries very often through self-evaluation activities. NCM also evaluates the activities it is involved in and helps to implement. There is a clear concern to see to it that all activities are integrated into total quality management as a key element of promoting long-lasting innovation in schools. The involvement of universities of university colleges in the monitoring of some of the activities such as the learning study activities is already an important step to assessing the quality of the innovative work done.

### **5.8. Focus on school development as a learning organisation**

It is important to stress that the innovations promoted in the framework of the action plan based on the Delegations report are seen as possible contributions to innovative school development. Key elements in this are the role of the reflective teacher in the framework of a team of teachers (cf. the learning study activities) , action-research work done by teams of teachers, professional development of teachers, exchange of good practice and experience between teachers (at the biennial conferences and the biennettes), the cooperation with other stakeholders in the local community (such as science centres or museums etc.) and the creation of local and regional networks to support innovation in education. All those elements contribute to turning the schools involved in the activities to enhance maths education into true learning organisations.

### **5.9. Clear role for initial and in-service teacher education**

If things are to change in maths education, important investments have to be made in the training of the teachers both in initial and in in-service training. This is definitely the case in Sweden where efforts are made on the one hand to attract more teachers into teaching maths and to train them better in close cooperation with schools.

One of the four key areas within which activities are launched to promote maths education is teacher education both initial and in-service. The focus is not mainly on the theoretical training of teachers but on the practical training and on the professional development of teachers by strengthening networking. Several of the activities of the action plan such as the network of municipal supervisors of maths, the organisation of biennial conferences, of biennettes, the study-circles (cf the hands-on math workshops), the learning study initiatives etc.

One can thus state that there is a clear interaction between initial, in-service training and classroom practice. It was suggested that towards the future learning study activities be integrated in initial teacher training so as to make future teachers aware of the potential of this approach.

#### **5.10. Descriptions of good practice, dissemination, valorisation**

Teachers are also greatly supported by the NCM through the different journals and websites that support the creation and the functioning of learning communities of teachers exchanging their concrete teaching practice.

Teachers have ample opportunity to describe what they are doing and to have their initiatives published in the different journals. In this way the NCM contributes greatly to have teachers describe what they are doing and disseminating good practice and research.

#### **5.11. Networking between various stakeholders at local, regional, national level**

A key strength of the action plan for maths is the fact that there is a strong networking and interaction between all the different stakeholders and groups that can promote maths education in Sweden. This is definitely the case in the region of Göteborg as NCM is operating in that region. However, several of its activities clearly focus on the development of initiatives at national and regional level. The creation and the implementation of the national network of maths supervisors in close cooperation with the municipalities is a good example of this. The link within this initiative of the supervisors with the regional centres in another example. The national conferences (Biennials) and the regional biennettes are other examples of this. It was also mentioned that representatives were visiting the regions so as to discuss with them the strengthening of the network of supervisors to support maths education. The cooperation between NCM and other national centre for physics, chemistry etc. (which exists so far in a limited way!) will also strengthen the networking at national level. One can thus conclude that the activities of NCM really try to strengthen networking at all levels which contributes to the implementation of the action plan.

#### **5.12. Networking at Nordic, European and international level**

It appears clearly that the Delegation's report and the subsequent action plan have not been developed in total isolation but have taken advantage of exchanges of information and expertise through European and international networking. The fact that a major international conference was organised that coincided with the drafting of the Delegation's report is a good example of this. The international and European experts were invited to put forward innovations which are taking place in their countries on the one hand and to reflect on the other hand on the Swedish situation as to maths education and come up with concrete proposals. This kind of proposals definitely lead to create cross-fertilisation taking advantage of the expertise and the experiments set up in other countries. It is important that countries that are deciding on innovative measures to be taken in school education, look across their borders to learn from other countries.

#### **5.13. Support by research**

It is clear that the reforms and strategies proposed as to maths education clearly try to build on the results of research in that particular area. Sweden is thus trying to see to it that there is a clear link between research in maths education and the application of the results of research into the concrete school situation or the teacher training

situation. One of the journals has this specific focus to promote research results not only at Swedish level but for the Nordic countries. Furthermore research into mathematics education is put also in a broader perspective through the links with the Nordic graduate school of mathematics education.

#### **5.14. Attention to Gender issues**

Gender issues are addressed in the present action plan but do not seem to be the key issue at the level of the school education system. However, there is concern about the number of women that take maths in higher education and the role they play in maths education at a higher education level.

The networking project presented at the PLA is a good example of promoting the role of women in mathematics in higher education.

#### **5.15. Interaction with / support of policy makers**

The Delegation and its report and the action plan outlined in it and subsequently implemented are the full responsibility of the ministry of education and research. The NCM is taking on board, more or less voluntary, the role to monitor and push forward the different activities proposed in the action plan. It seems there is a constant interaction and exchange of views between the policy makers and NCM so that the former are well-informed about the actions set up by NCM and the effect or impact those actions have. Strong and open interaction between the decision-makers at the level of the ministry (and other national agencies) facilitates the implementation of the strategy and guarantees the moral and the financial support necessary to implement a long-term strategy.

### **6. Issues that require particular attention towards the future in Sweden**

It has to be stressed that participants to the PLA were quite impressed both by the Delegation's report and by the subsequent action plan which is largely implemented thanks to the motivation and dedication of the NCM colleagues in close cooperation with several stakeholders. A few weaknesses should, however, be mentioned which require the special attention of the Swedish Ministry of Education and Research.

#### **6.1. Coordinating role and coaching role of the NCM**

The strong support, commitment and vision of the Swedish Ministry of Education and Research and of the Swedish National Agency for School Improvement are vital to the success of the implementation of the action plan for maths.

The coordination and coaching role of NCM is, according to the PLA participants, THE driving force in the implementation of the action plan. However, apparently NCM has not been assigned this role officially. It would be good that towards the future this coordinating , monitoring and support role of NCM as to the implementation of the action plan is clearly outlined and officially recognised.

Participants highlighted the following characteristics of the NCM in supporting the maths action plan:

- A centre with experienced and dedicated staff
- A clearly shared vision and mission amongst all staff members
- Actions, activities built on deep discussion and thorough reflection as a team

- A centre that facilitates and strengthens networking at local, regional and national level facilitating strong outreach at all those levels
- An operational network with flexibly responds to new challenges
- An integrated way of working across the whole staff
- A centre embedded in European and international network
- Strong links with research
- Making available to beneficiaries high quality support mechanisms such as websites, journals, projects etc.
- Constantly evaluating its activities in the light of the action plan.
- NCM is a key player in the middle of the field!

## **6.2. The financial support to monitor the strategy**

The financial support for the implementation of the strategy seems to be assigned on a project or temporary basis (very often ranging from one to two years). If the long-term action plan is to be successfully implemented and is to bear fully its fruits, it would be good if a clear and detailed pluri-annual budget would be made available to NCM as a coordinating structure. In this way it could operate more as the Platform Bèta Techniek of the Netherlands does. This long-term support should be clearly linked to concrete (qualitative and quantitative) objectives (to be measured through clear indicators) to be achieved by the NCM.

## **6.3. Cooperation between different national centres**

At the moment there is different cooperation between the NCM, the National Centre for Mathematics Education and similar centres such as the National Centre for physics , the national Centre for Chemistry etc. Timid forms of cooperation have been started up at the moment involving those different centres. It would be good towards the future that strong and regular cooperation is set up between all those centres and the ministry (plus its agencies) so as to contribute to a comprehensive coherent strategy as to the promotion of maths, science and technology education.

It was suggested that it would be useful to open up the biennial maths conferences to representatives of all the other centres so as to create more synergy.

One of the participants to the PLA pointed out that the link between NCM and maths in sciences seem to be rather weak at the moment.

## **6.4. Involvement of companies**

So far most of the activities outlined in the framework of the maths strategy are implemented without little or no involvement of companies. Reference was only made twice to the role of companies: once as to the initiative for maths in the primary school which is launched in the framework of the European Round table of industrialists. The second reference had to do with the involvement of companies in the INTIZE initiative of the students of engineering of Chalmers University of Technology who mentor disadvantaged pupils in the secondary schools.

More attention could possibly be given to linking up with or involving companies in math activities or linking maths and sciences activities with companies. This could possibly also have an impact on the entrepreneurial competence of the pupils, one of the eight key competences for lifelong learning approved by the European Parliament and the Council of Ministers.

## **7. Other key issues addressed by PLA participants in Göteborg**

### **7.1. The transition from higher secondary to university**

The transition from higher secondary education to university education was discussed at the occasion of the presentation concerning special initiatives in the field of maths to facilitate the transition to higher education.

It was mentioned again that the fact that in Sweden (as in other Nordic countries such as Norway) the final choice of the pupils is delayed till the end of the compulsory school (till 15 or 16 years of age), had a positive effect on the choice of the students. Last year at the PLA in the Netherlands it was clear that the early choice pupils had to make, e.g. at 12 years, was a major problem.

Norway stressed that it is developing a continuous curriculum all through the compulsory school (from 6 to 16), through upper secondary and through higher education so as to try to reduce the transition problems.

It also stressed that flexible ways of learning facilitated the transition. Pupils in the final year of the upper secondary schools that are good in subjects like maths and science, are allowed to take some subjects in the first year of higher education. Pupils of the final year of the compulsory school that are good in those subjects can take the subject in the first year of the upper secondary school. This definitely stimulates the interest and motivation of the pupils concerned.

Last year in the PLA in the Netherlands, the University of Utrecht presented its Junior college initiative enabling pupils in the final years of the secondary school to take courses at the university in this special junior college.

### **7.2. The assessment issue**

One of the discussions focused on which assessments can be used to assess the results of the innovative methods and approaches promoted in the strategy. Participants agreed that as far as pupils are concerned testing also has to be studied carefully so as to find 'new' ways to assess which competences, knowledge and skills have been acquired. Teachers of maths also have to make efforts to integrate their maths learning into exercises or scenarios that are linked to real life situation and make the use and importance of maths tangible. Testing is definitely a tricky issue and has to be revised if competence-based learning has to get the major focus.

It was added that a thorough discussion of assessing maths, science and technology should be looked into detail during another meeting of the cluster.



## 8. The impact and effect of PLAs

At several occasions it was stressed that the former PLA in November 06 and the present one in May 07 have a strong effect and impact on the policies conducted in the participating countries.

A few concrete examples can be given to clarify this statement of participants:

The coordination model – the Platform Bèta Techniek -of the national strategy as to science and technology used in the Netherlands has generated a lot of interest. Some of the participating countries (DK, Cyprus, Portugal, Sweden, and Norway) could be visiting the Netherlands to get more information about it.

The science museum, science fairs and the science centres visited during the two PLAs have inspired several countries (Cyprus, Denmark) to look into the possibility to develop such centre and to make them play an active role in the promotion of maths, science and technology education.

The next generation science initiative of the British Council set up in the framework of cooperation between England and the Netherlands seems to be of interest to other countries. Cyprus is looking into the possibility of launching this initiative.

The cooperation between companies and schools or other educational stakeholders as the Jet Net project in the Netherlands has inspired several participants (Norway, Cyprus, Portugal) that look into developing similar models.

The promotion of motivation and interest for maths and science through mentoring activities set up by students has created great interest with all participating countries. The activities of the Stichting Techniek promote of the Technical university of Delft and of the INTIZE initiative both are founded on engineering students promoting maths and/or science with pupils in secondary schools. Norway has already started implementing a project based on the INTIZE project with engineering students.

The promotion of interest for maths and science with girls as implemented in the framework of the organisation VHTO with activities such as speed-dating, promo-teams and mentoring of girls has also created great interest with PLA participants. Some think of implementing similar models.

### **Report of the Danish participant to the PLAs in SE and NL**

*I find it very inspiring to meet colleagues from other European countries. And the PLA in Sweden (and in Holland) has given a direct input to an important process in Denmark: The Minister of Education and the Minister of Science, Technology and Innovation has just established a working group that should put forward suggestions for a National Strategy for Science, Technology and Health. The aims are of course to improve the science skills of pupils and students at all levels of education and to improve recruitment to science.*

*In the process of forming a National Strategy for Science, Technology and Health in Denmark*

*the direct input from the PLA's are:*

- 1. In Göteborg it was presented how the Mathematics Delegation had worked in Sweden when they made a "national strategy of maths". From that the Danish working group has learned about a) organising the work with subgroups of special interests, b) using an open homepage, so that teachers etc. can give input to the process, c) structure of the final report.*
  - 2. One of the elements in the National strategy of Denmark will be focusing on the problems going from compulsory school to upper secondary and from upper secondary to higher educations. The Intize project about mentoring in mathematics was very inspiring and Farid, the student in charge of the initiative, will be invited to speak at a conference in Denmark.*
  - 3. Within the same subject as point 2 above: It was interesting to hear about the Swedish three-year project about courses of mathematics (web-based) to reduce problems in the transition from upper secondary to university. This might also be a part of a Danish strategy.*
  - 4. Optimizing the effect of visiting science centres also probably will be a focus point. Therefore it was very interesting to visit Navet in Borås. Special focus could be given to the way a visit of a school class was prepared and also followed after the visit.*
  - 5. In Denmark we are planning to build resource centres as "The National Center for Mathematics Education" in Göteborg. The PLA made clear that NCM has an important role in Sweden. And as a result members of the Danish working group will visit NCM in the autumn of 2007.*
  - 6. The PLAs has also given input about the initiatives in Holland. As a result members of the Danish working group will probably visit Holland in the autumn of 2007. The goal is to know some details of organizing the national strategy in Holland and to hear about the results so far.*
  - 7. In connection with the PLAs in Holland and Sweden we have heard about the Norwegian national strategy. Members of the Danish working group will visit Norway in the autumn of 2007.*
- This indicates why I believe that the work of the expert group is fruitful.*

## 9. Evaluation of the PLA in Göteborg

### Evaluation PLA Sweden

The overall introductory remark is that all the participants thought the PLA to be a very useful and enriching exercise to review the development and the implementation of the action plan in the field of maths education in Sweden. The PLA proved particularly useful as all countries participating are concerned by raising in the interest and motivation for maths on the one hand and by raising the quality of the learning and teaching of maths at all ages.

The Swedish colleagues stressed that it was very useful for them to have 'critical friends' reflecting on the action plan in Sweden towards future further actions.

The hope was clearly expressed that the future PLA would go on deepening the discussions and the comparative review of the policies in MST.

The PLA was really a valuable experience. It was a great pleasure to take part because our limited time was really well filled with relevant informations, in a convincing order and presented by all of the actors in an infecting spirit and commitment!!!

Comments of a participant

The summary of the evaluation questionnaires

*The information in this section is based on the evaluation forms filled in by participants to the PLA. The evaluation form is added as annex n° 6*

All the PLA participants agreed that the programme was well to very well balanced and gave a full overview of the different parts and issues related to the maths education.

The PLA participants agreed that the programme really enabled to meet all the actors and beneficiaries at all levels: senior officials, decision-makers, teachers, heads, inspectors, universities, students, pupils etc.

All the PLA participants agree that the Swedish colleagues of the Ministry of Education and Research and many colleagues of the NCM met were always available to answer any question at any time.

Most of the PLA participants thought that more time should be made available to reflect on the issues and to discuss them in depth. The time issue remains a concern but it is difficult to make a choice between more or less information and more or less discussion.

All the PLA participants fully agreed to the fact that clear information on the objectives of the PLA was available before the PLA itself.

All the PLA participants agreed that the information which was sent to participants in advance (such as the background paper) was very useful. Also all the information received during the PLA proved to be very interesting and useful.

All the PLA participants agreed that the information given by participants as to maths education in their respective countries were complementary to the core topic and issues of this PLA.

All the participants agreed that the discussions within the PLA group were well organized and fruitful (but too short as mentioned earlier!). Some thought that the powerpoint presentation summing up everything on the final day proved to be very useful.

All the PLA participants agree fully that the programme was very well organized and smoothly implemented. There was nothing but praise for the organisation of the whole event.

All the PLA participants agreed that the PLA has proven or will prove to be useful for policy development and policy implementation in their countries. Several examples were given on how the previous PLA had proved to be useful and have an impact on policy in the respective countries. Some mentioned that this would be definitely the case also this time.

The lessons learnt towards future PLAs

The length of a PLA

Three to four days was agreed to be the right length of a PLA. Definitely not shorter as time is required to combine the moments of information, the site visits, the meetings with stakeholders, the presentations of participants and the periods of reflections during the PLA.

The elements composing a PLA

All the elements mentioned in the document drafted as the basis for the PLA in MST were considered to be valuable to a PLA. No major additions or changes are required. However, in the evaluation PLA participants stressed that maybe more time had to be scheduled for the explicit reflections and discussions within the group of participants.

The role of the host country

The host country had fulfilled the role it was supposed to play. It had organised and implemented a very rich programme. The preparatory meeting in Amsterdam during the 1<sup>st</sup> PLA in November 2006 and subsequent regular contacts have greatly contributed to the success together with the commitment of the colleagues of the Swedish Ministry of Education and Research and the National Centre for Mathematics Education.

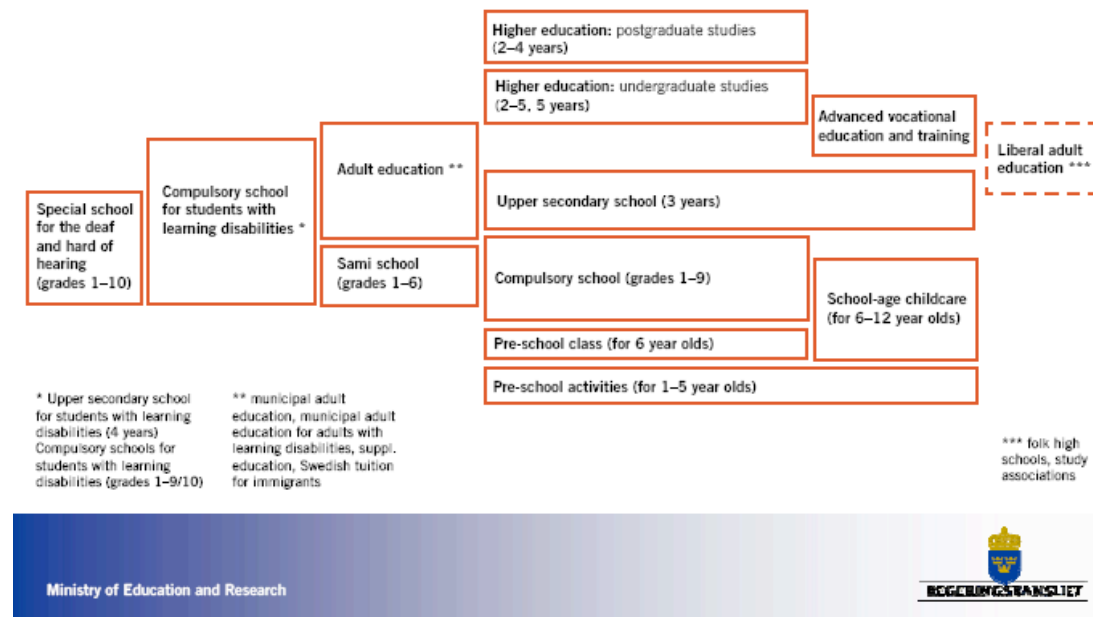
The role of the participating countries

As mentioned already earlier, the contributions of the participating PLA countries were thought to be useful and complementary. The information and concrete elements and reflections they brought in the discussions triggered a useful and enriching debate.

## 10. Annexes

### Annex 1: The Swedish educational System

## The Swedish Educational System



source: <http://www.regeringen.se/content/1/c6/07/92/85/f899a8ee.pdf>

#### The pre-school system

The Swedish childcare system includes pre-school activities for children between one and six years of age (for those who do not attend a pre-school class or school-age childcare) and school-age childcare for school children of six to twelve years of age. The pre-school system consists of pre-schools, family day-care homes and open pre-schools. School-age childcare consists of family day-care homes and out-of-school centres.

#### The pre-school class

The pre-school class is a voluntary form of school within the state school system. Municipalities are required to offer children places in pre-school classes from the autumn term of the year in which a child turns six until the child starts his/her compulsory schooling.

#### Compulsory school and other compulsory types of school

The compulsory school system comprises primary and lower secondary schools, Sami schools, special schools for students with impaired sight, hearing or speech, and special needs schools for students with learning disabilities. Schooling is compulsory and free of charge. Parents do not usually incur any costs for teaching materials, school meals, health care or school transport.

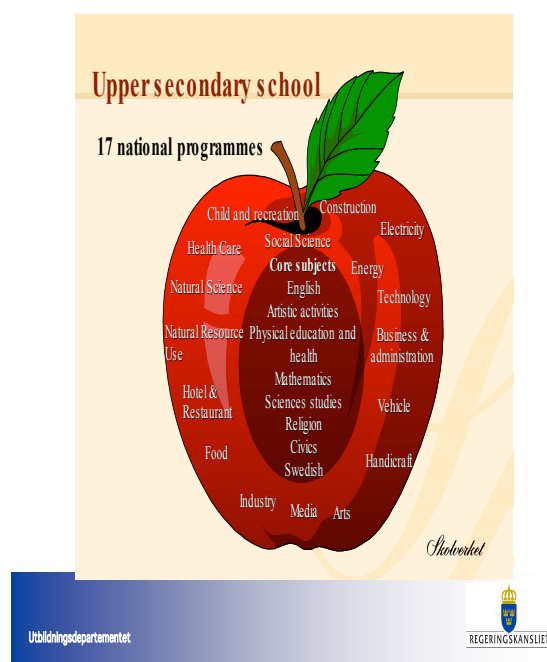
Most children with hearing impairments and nearly all visually impaired and disabled children are taught in compulsory schools. However, deaf children and children with serious hearing impairments go to special schools. Special schools

comprise ten grades and are to provide education that is equivalent, as far as possible, to that given in compulsory schools. There are also special schools for deaf children or children with hearing impairments who are intellectually disabled.

Special needs schools are available for intellectually disabled children. Compulsory special needs schools comprise nine grades, either at primary and lower secondary special needs schools or training schools. Children with minor intellectual disabilities go to primary and secondary special needs schools. Training schools are for students who are so intellectually disabled that they are unable to benefit from education at special needs schools at primary and lower secondary levels. Students at special needs schools are entitled to a tenth school year. Sami children can receive Sami-oriented education in Sami schools. This education corresponds to the first six years of compulsory school.

### Upper secondary school

Upper secondary schools are divided into 17 three-year national programmes. All these programmes provide basic eligibility for further studies in H. Ed. Parallel to the national programmes are also specially designed, individual programmes.



### About the school system

The Swedish Education Act stipulates that all children and young people must have access to equal quality education, irrespective of gender, their geographical place of residence and their social and financial situations. Sweden has nine years of compulsory schooling from the age of seven and education throughout the state school system is free of charge. Alongside the state school system are independent schools, open to all. Independent schools must be approved by the National Agency for Education. Education at independent schools must have the same objectives as municipal schools but may, for example, have a religious or educational profile that differs from that of municipal schools.

Universities and other higher education institutions in Sweden are autonomous agencies, directly responsible to the Government.

There are 14 universities and 22 higher education institutions whose principal is the state, which means that responsibility ultimately lies with the state. In addition there are ten or so private education providers, including Chalmers University of Technology, Jönköping University and the Stockholm School of Economics.

The main task of the state universities and higher education institutions is to organise educational programmes based on scientific or artistic foundations and proven experience.

The objective of **research** policy is that Sweden should be a leading research nation, where research of a high scientific standard is conducted. Every society needs independent researchers who formulate ideas independently and objectively and who analyse, question and actively take part in public debate.

**Swedish adult education** is extensive and has a long tradition. Adult education takes many forms, from state or municipal adult education to employment training, staff training or continued professional development in working life. Liberal adult education has a long history in Swedish adult education. It is characterised by the fact that it is "free and voluntary", that is, free from central government control and voluntary for its participants. Liberal adult education primarily includes activities conducted by folk high schools and study associations. The Swedish state allocates just over SEK 2.5 billion per year to liberal adult education.

## Annex 2: Programme Göteborg PLA

Program for Peer Learning Activity of the MST Cluster, May 21–24, 2007  
National Centre for Mathematics Education, NCM,  
Göteborg University, Sweden

Monday 21

Morning Arrival, Hotel Gothia Tower, Göteborg

13.00 Welcome and introduction at NCM, Göteborg University

*Bengt Johansson*

The Swedish school system – focusing on mathematics education

*Erik Henriks*

14.00 The suggested program of the Mathematics Delegation and reports from recent studies

and national commissions of inquiry. What has happened after the Mathematics Delegation? *Lars Mouwitz, Anette Jahnke, Bengt Johansson*

16.00 Time for discussion and evaluation

20.00 Welcome Dinner

Tuesday 22

08.00 Departure – by bus (20 minutes drive)

Learning Study in Mathematics – Visiting a compulsory school participating in developmental work in mathematics classrooms in cooperation with researchers

*Ference Marton and teachers at Öjersjö school, Partille municipality*

10.00 Departure – by bus to Chalmers University of Technology (20 minutes drive)

10.30 Visiting Chalmers. Meeting students from lower and upper secondary schools participating in activities for increasing the recruitment of minority students to higher

education, creating interest for MST. Started and run by students of engineering  
*Intize*

12.00 Lunch. Then departure (by bus) to Borås 60 km from Göteborg

13.30 Visiting, “Navet” (“the Hub”), a Science Center focusing on mathematics

*Lotta Johansson and colleagues*

15.30 Time for discussion and evaluation

16.30 Back to hotel

18.00 A guided tour in downtown Göteborg

Wednesday 23

09.00 The National Center for Mathematics Education, NCM:

– Websites, Kangourou des mathématiques,

journals and literature: NÄMNAREN, N-TEMA, Normat, NOMAD

*Anders Wallby, Karin Wallby, Ola Helenius and Johan Häggström*

– Examples of national projects/initiatives for improving mathematics education

- International perspectives, *Göran Emanuelsson*

- The Biennial conferences, *Göran Emanuelsson*

- Small Children's Mathematics, a pre-school project, *Lillemor Emanuelsson*

- Hands-On Mathematics in teaching and in-service education, *Lena Trygg*

12.00 Lunch

13.00 Continuing ...

– “Matematikutvecklare” – A national network and initiative for supervisors of mathematics for in-service education and school development at municipality level

*Elisabeth Rystedt*

– Transitions from upper-secondary to university, a three-year project



*Anette Jahnke*

– Adults and mathematics, a vital subject and The EMMA–project

*Lars Gustafsson*

– NCM – a summary

*Ola Helenius*

16.00 Time for discussion and evaluation

19.30 Dinner

Thursday 24

09.00 – The Swedish system for teacher training, *Myrna Smitt*

– The Swedish and Nordic graduate school of mathematics education,

*Barbro Grevholm*

– Women and mathematics in Sweden, *Barbro Grevholm*

– National initiatives at The Swedish National Agency for School Improvement,

*Anna Engdahl*

12.00 Lunch

13.00 Discussions and reflections within the PLA Group

Presentations by some of the PLA participants

Preparing for the final report

Evaluating of the PLA

Closing remarks, Farewell, Departure

### Annex 3: Participants and Participating countries

EU participants except Sweden

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## List of Swedish speakers and participants

Ministry of Education and Research and related services

Erik Henriks, Senior Advisor, The Ministry of Education of Sweden  
Myrna Smitt, Deputy Director, The Ministry of Education of Sweden  
Anna Engdahl, Director of Education, The Swedish National Agency for School Improvement  
Barbro Grevholm, Professor of Mathematics Education at Agder University College, Norway and  
Kristianstad University, Sweden.

Öjersjö school, Partille

Ference Marton, Professor of pedagogy, Göteborg University  
Johanna Wallinder, grade 1-7 teacher  
Maria Bergqvist, grade 1-7 teacher  
Joakim Magnusson, grade 4-9 teacher  
Henrik Hansson, grade 1-7 teacher  
Ingalill Carlsson, special education teacher  
Tuula Maunula, grade 4-9 teacher  
Christina Echevarria, grade 4-9 teacher  
Tobias Sundin, grade 4-9 teacher

Chalmers University of Technology

Intize, students of engineering at Chalmers University of Technology and Göteborg University  
together with lower and upper secondary school students

Navet

Lotta Johansson, Director  
Nina Karlsson, teacher  
Riitta Carlström, teacher  
Anna Gunnarsson, teacher  
Fedoua Beckerman, PhD  
Sara Bagge, Licentiate

NCM

Jesper Boesen, Project leader, PhD  
Göran Emanuelsson, Deputy director, PhD.h.c.  
Lillemor Emanuelsson, Project leader  
Lars Gustafsson, Project leader  
Ola Helenius, Project leader, Editor, Normat, PhD  
Johan Häggström, Editor, Nordic Studies in Mathematics Education, NOMAD  
Anette Jahnke, Project leader, Licentiate  
Bengt Johansson, Director  
Lars Mouwitz, Investigator, PhD  
Elisabeth Rystedt, Project leader  
Lena Trygg, Project leader  
Anders Wallby, Web Editor  
Karin Wallby, Editor NÄMNAREN

#### **Annex 4: Useful websites**

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/](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](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](http://www.ert.be/working_group.aspx?wg=102)

## Annex 5: Useful reading

**All the PPT PowerPoint Presentations given at the PLA on Maths are to be found on the following NCM website:**

<http://ncm.gu.se/node/1959>

Att lyfta matematiken – intresse, lärande, kompetens; September 2004

ISBN 91-38-22218-3

<http://www.regeringen.se/content/1/c6/03/03/48/6a32d1c0.pdf>

Education and training in Europe: A report on education and training in Sweden and the shared European goals; November 2003; Swedish Ministry of Education and Research.

Descriptive data on pre-school activities, school-age childcare, schools and adult education in Sweden 2006; Skolverket (National Agency for Education);

<http://www.skolverket.se/sb/d/356/a/1326;jsessionid=138EB040C899CA2BB295E27C1CFEA95F>

Reference levels in School Mathematics Education in Europe

National Presentation of SWEDEN by *Gerd Brandel*, June 2000

See website:

[http://www.emis.de/projects/Ref/doc\\_ems\\_pdf/EMS\\_NATIONAL\\_PRESENTATIONS/EMS\\_SWEDEN.pdf](http://www.emis.de/projects/Ref/doc_ems_pdf/EMS_NATIONAL_PRESENTATIONS/EMS_SWEDEN.pdf)

Commission staff working document: Progress towards the Lisbon objectives in education and training; Report based on indicators and benchmarks; Report 2006

<http://ec.europa.eu/education/policies/2010/doc/progressreport06.pdf>

Recommendation of the European Parliament and of the Council of 18 December 2006 on key competences for lifelong learning (2006/962/EC) (OJ L 394, 30.12.2006)

[http://eur-lex.europa.eu/LexUriServ/site/en/oj/2006/l\\_394/l\\_39420061230en00100018.pdf](http://eur-lex.europa.eu/LexUriServ/site/en/oj/2006/l_394/l_39420061230en00100018.pdf)

Progress reports of MST plus other key EU documents

[http://ec.europa.eu/education/policies/2010/objectives\\_en.html#math](http://ec.europa.eu/education/policies/2010/objectives_en.html#math)

Science teaching in schools in Europe. Policies and research; 2006

<http://www.eurydice.org/portal/page/portal/Eurydice/showPresentation?pubid=081EN>

Lesson study: a handbook of teacher-led instructional change, Catherine C. Lewis

<http://lessonresearch.net/briefguide.pdf>

## Annex 6: The evaluation form

The evaluation form for the Goteborg PLA, 21 - 24 May 2007

1= I disagree

2= I agree more or less

3= I agree

4= I fully agree

	1	2	3	4
1.The programme was very well balanced as to the contents giving a full overview of the different parts and issues related to the Delegation's report and subsequent Action Plan for Maths.				
2. The programme enabled the participants to meet all the key actors or beneficiaries at all levels: senior officials, decision-makers, teachers, heads, inspectors, universities, students etc.				
3. The colleagues of the host country were available to answer any question at any time				
4. There was enough time for discussions within the group of participants of the PLA				
5. Clear information on the objectives of the PLA were available before the PLA itself				
6. The information sent to participants in advance proved to be very useful in preparing oneself for participation				
7. The presentation made by participants of the PLA were complementary to the core topic and issues of the PLA				
8. The discussions within the PLA group were well organised and fruitful				
9. The PLA was very well organised and smoothly implemented				
10. The PLA has proved / will prove to be useful for policy development and implementation in my country				

Please add comments for any of the topics or issues mentioned above  
Take as much space as you like!

1.
2.
3.
4.
5.
6.
7.

8.
9.
10.

Please send back by e-mail to Yves Beernaert by **22 June 07**  
yves.beernaert@educonsult.be  
Educonsult  
**00 32 474 987411**