Current issues on Mathematics Education around Europe

Introduction
In all the meetings of the EMS- Educational Committee, updated reports are presented by the participants on the current situation related to mathematics education in their countries. Although these reports express the members’ personal opinions and do not necessarily reflect national institutional views, they address important issues that provide an initial comparative picture of mathematics education in Europe. The countries that are represented in the reports are Austria, Belgium, Czech Republic, Denmark, England, Finland, France, Germany, Greece, Israel, Italy, Portugal, Russia and Spain. In this short paper, the discussion will be around four main aspects that have been addressed in most reports concerning: the overall educational and social matters that have an effect on mathematics education in different educational levels; the curriculum, and the teacher education and professional development. Finally the role of local associations, research groups and national projects is also a factor that seems to influence mathematics education at the levels of both research and practice.

Social and Educational Issues
Financial crisis around Europe, especially in some countries (e.g. Greece, Italy, Portugal, Spain), has resulted in salary cuts in the public sector and a number of educational changes (e.g. merging of schools and universities, reduction of funding, increase of the number of students in the classroom) each of which have had a negative impact in many teachers’ motivation. In many countries, for example in France, Denmark, England, Israel and Germany, there is shortage of school mathematics teachers for all or for some levels of educations and in some cases where mathematics teaching is undertaken by out-of-field-teachers, there is the problem of rather low mathematical background even if their engagement is not problematic. In France, another reason that seems to create unwillingness for graduates to choose the teaching profession is the sheer number of challenges: the recent reform requires that they must simultaneously get a Master degree, succeed in the national competition for teacher recruitment, and teach full time in schools, with no professional preparation.
In general, the public image of mathematics seems to be on a negative trend, with the number of university mathematics graduates decreasing dramatically and many mathematics departments having major difficulties in attracting students for example in Spain, Denmark, Russia. An exception to the negative trend in mathematics recruitment at higher levels in school and into mathematics undergraduate courses is England where numbers have risen year on year over several years. Even in countries with strong mathematical traditions such as Russia, the positive image deteriorates. In Russia, mathematics education works at two different levels: at a very high level in specialized math-physics schools and at some universities, and at a much lower level elsewhere. Finally, politicians in most countries are keen to see a rise in students’ achievement in international comparative studies (like PISA and TIMSS) and this has an impact on mathematics education in the country. For example, a number of educational innovations (e.g. new mathematics curriculum, in-service teacher education programs, EU-wide dissemination programmes like Fibonacci and PRIMAS) have been designed to try to improve outcomes in these studies.

**Curriculum Innovations**

At the school level, new curricula have been designed recently or are in the process of development in the Czech Republic, Denmark, England, Greece, Israel, Portugal, and Russia. For example, in the Czech Republic the new curriculum was introduced first for compulsory education and then for upper secondary level. This curriculum is currently being evaluated and necessary modifications are proposed. In Denmark, new curricula for the primary and lower secondary levels and for the different streams of the upper secondary level were put in place 2005-2010. The changes of the general stream of the upper secondary level were rather marked, breaking with the tradition in several respects, e.g. by giving considerable emphasis to applications and to the role of CAS calculators in executing mathematical processes, while manifestly reducing the role of mathematical proof. This has given rise to quite some discussion amongst mathematics educators, teachers and mathematicians. In Israel, new preschool and primary school mandatory curricula have been implemented a number of years ago. A new junior high school curriculum is currently being implemented and revised; one of its characteristics is the stress on applied settings. A committee of leading teachers, teacher educators, academics and education ministry representatives is currently designing a new high school curriculum at four levels: theoretical, scientific, general
and applied. In England a new draft National Curriculum is under consultation with quite radical changes proposed particularly for the primary phase with a return to more ‘formal methods’

In most countries, mathematics education at the compulsory level emphasizes problem solving, reasoning and communication and the idea of developing students’ mathematical literacy. Debates take place between mathematicians and mathematics educators in some countries about the quality of curriculum concerning mathematics and pedagogy. In the interests of openness and honesty, we cannot ignore that in some places there is a struggle between these two groups: in some cases even to the point of “math warfare”. Sometimes, information on both sides is lacking. An interest of our committee is in fact to improve communication. At the university level, in all the countries except Russia and partly Denmark, the universities design their own study programs and some attempts have been made to improve mathematics teaching.

Developing educational standards and new examination systems has also been a goal for many European countries. For example, in Austria educational standards have been developed and field tested for grades 4 and 8 for a number of school subjects including mathematics (in 2012, the testing started with M8) while in Germany there are intensive discussions on standards of mathematics teaching and models of competencies in mathematics are successfully established and discussed. In Russia an important development is the nationwide implementation of the Unified State Examination (USE) in mathematics (and other subjects). The USE has two functions: first, to control and unify the high school diploma examinations and, second, to serve as the main criterion for entering university (thus replacing the entrance exams organized by the universities themselves in previous years). This year the selection of math problems at the USE was generally regarded as very appropriate, nevertheless there is a strong feeling in the mathematics education community that the USE should be replaced by two separate examinations, each performing one of the two functions mentioned above. Changes to entry examinations at the university have been planned or are being designed in many other countries such as Austria, Czech Republic, Germany, and Greece.

Some of the changes about examinations are the introduction of standardized tests and their organization centrally (fully or partially) at a national level. In England there has been national testing at ages 7, 11, 14 and 16 years and monitoring across core
subjects including mathematics for many years. Interestingly this huge edifice of testing is now gradually being reduced (to date national tests at ages 7 and 14 have been discontinued). The number of school years at which national tests for school mathematics are organised varies across countries. In Spain national testing is more narrowly practiced, for a lower number of years and only for compulsory mathematics education. In the Netherlands, there is an ongoing public debate about the direction of the mathematics curriculum of the future, especially at the elementary school level, between advocates of reform-based mathematical curricula and approaches (who are strongly inspired by the ideas and materials developed by the Freudenthal Institute) and advocates of more traditional, back-to-basics approaches.

**Teacher Education and professional development**

The issue of teacher education and professional development has been a central issue of educational policy in many countries. Five European countries (Germany, Norway, Russia, Spain, and Switzerland) participate in the international study TEDS-M that aims to examine how teachers are prepared to teach mathematics in primary and lower secondary school (http://teds.educ.msu.edu). Teacher education is usually organised at university or at college level and differs for primary or secondary school teachers. For example, in Portugal the path for primary school teaching is through the study in special schools belonging to the Polytechnical system where the focus is on the study of all subjects and their didactics. At the secondary level, the prospective teachers study three years mathematics followed by two years of courses with an emphasis on mathematics, didactics of mathematics and fieldwork. A similar situation exists in Belgium, although recently some initial steps have been taken in the direction of requiring an academic master degree for all future teachers. In Denmark, the education of primary and lower secondary teachers takes place in teacher training colleges and not at universities. The programme for these prospective teachers is defined by the parliament, and due to continuing dissatisfaction with the outcomes of primary and lower secondary teacher education, the government and the parliament keep changing the programme, often even before the previous programme was put into full practice. At the upper secondary level, even though a Master’s degree in mathematics and another subject is required, the lack of teachers for this level has implied a reduction of this requirement in practice. The situation in Israel is similar to the one in Denmark. In Spain, at secondary level an extra requirement to become a
school teacher has been introduced that is to undertake a one year’s masters’ program designed by mathematics and education departments in collaboration. In Greece, a new law has been introduced that a teaching certificate is required for teaching at school and the mathematics departments have started to discuss about organizing courses leading to this certificate. In England there are many routes into teaching – from school-based courses run by schools (with university accreditation) to one year post graduate courses at universities. The training for primary teachers is generalist, but given the importance given to mathematics there are moves to introduce more mathematics specialism. In Austria, there are recent innovations about teacher education with an emphasis on the establishment of education infrastructure that would support teachers both at the pre-service and in-service level. For example, a number of regional networks for teacher collaboration, six national and eighteen regional subject-didactics centres have been established (IMST project). In Germany, a German Centre for Continuous Professional Development (DZLM) for mathematics teachers has been established adopting some ideas from the successful National Centre of Excellence of Teaching Mathematics (NCETM) in England and from the establishment of centres and networks as initiated by the Austrian IMST project.

Another issue that seems to be of concern for many countries is teachers’ mathematical knowledge especially at primary level. For example, some preliminary results from the TEDS-M Study show the need to reinforce primary school teachers’ mathematical knowledge. Also in a recent report of the Dutch Royal Academia of Sciences, the need to enhance elementary school teachers’ mathematical content knowledge, as well as their pedagogical content knowledge, is mentioned as one of the greatest challenges for the improvement of the quality of elementary school mathematics (http://www.knaw.nl/smartsite.dws?id=26103&pub=20091080). This is particularly recommended in countries like Spain in which primary teacher education programs have been proved to give priority to the teaching and learning of general pedagogical contents.

**Associations- Research Groups-National and International Projects**

In many European countries, mathematical and mathematics education associations and research groups are very active in collaborating with teachers, organizing national conferences for teachers and taking part in reforms and national projects (e.g. France, Portugal, Spain, the Netherlands). A number of National Centers have been
established that support education in general and mathematics education in particular. In Austria, six Austrian Educational Competence Centres have been established and are involved in the current educational developments. In Israel, two National Teacher Centres are active, one for primary and the other for secondary schools; they offer in-service training, resources like learning activities and ICT tools, publish teacher journals, translate relevant scientific articles, and maintain the contact between teachers and the education ministry. In Finland and in Germany (see above), a mathematics and science centre is also established that organises various activities for promoting the image of mathematics in students, teachers and parents such as special days at school, scientific clubs, teacher training courses. Finally some European projects such as the PRIMAS (www.primas-project.eu) and Fibonacci (url) support mathematics teachers’ professional development. We would like to be aware of further joint European projects and initiatives. In England, The National Centre for Excellence in the Teaching of Mathematics (NCETM) was set up in 2006 by the U.K. government and has a contract to continue to March 2015. The Centre aims to meet the professional aspirations and needs of all teachers of mathematics through evidence-based CPD provision. The National Centre encourages schools to learn from their own best practice through collaboration among staff and by sharing good practice locally, regionally and nationally. These collaborations take place face-to-face at national and regional events and in local network meetings across England, or virtually, through interactions on the NCETM portal, www.ncetm.org.uk.

**Authorship**

Even though certain authors have taken the lead in each article of this series, all publications in the series are published by the Education Committee of the European Mathematical Society. The committee members at the time of writing this report were Ferdinando Arzarello, Tommy Dreyfus, Ghislaine Gueudet, Celia Hoyles, Konrad Krainer, Mogen Niss, Jarmila Novotná, Juha Oikonen, Núria Planas, Despina Potari, Alexei Sossinsky, Peter Sullivan, Günter Törner and Lieven Verschaffel.