

Proposal for a joint UNESCO Intergovernmental International Mathematical Program

International Mathematical Union (IMU)
International Commission on Mathematical Instruction (ICMI)
International Council for Industrial and Applied Mathematics (ICIAM)

November 2009

1 Reasons for launching the program

The World Science Forum in Budapest (November 2009) issued the following call:

Mathematics plays a rapidly increasing role as a universal language for science. Without it, science and technology cannot address the complex issues facing the modern world. At the same time, mathematical illiteracy is growing and interest in the study of mathematics is declining. The World Science Forum therefore calls for an international effort to improve mathematical research, education and awareness in all countries, and asks UNESCO, together with the scientific community, to take the lead in launching such an action.

Similar thoughts have been expressed by a UNESCO resolution in 1997 (Appendix 2). Some of the considerations behind this call are the following.

- It is well recognized by various scientific communities, social sciences included, that in the 21st century mathematics will become a universal language of research.
- In an increasingly digitalized and interconnected world mathematics is the key to understand, describe, analyze and predict complex processes. Besides its traditional role in science and engineering, this includes social, environmental, and economic phenomena.
- There has been a spectacular progress in pure and applied mathematics in recent years.
- In interdisciplinary work by UNESCO and other organizations, mathematics as a common language can facilitate mutual understanding.

At the same time,

- Among the general public, literacy in mathematics and in the natural sciences is decreasing dramatically.
- There is an unjustified fear of exact sciences, in particular, of mathematics. This hinders rational decision making, and will have severe effects on the technology of the future.
- The gap between developed and developing countries in mathematics is widening, from elementary schools to universities to professions such as engineering. This is a most serious obstacle in the technological development of these countries.
- Mathematics is losing ground in the so-called developed countries as well; this is reflected in dropping enrollments, and the disaffection for mathematics careers at all levels, and in particular at the level of teachers.

2 The scope of the program

UNESCO is in a unique situation to help solve the mentioned problems. It has also made some important starting steps, including the support of the World Mathematical Year 2000. We recommend that UNESCO extends its effort, in cooperation with the international scientific organizations signing this proposal, by launching an Intergovernmental *International Mathematical Program*.

In the design of this program, the following principles should be taken into account:

(1) *Mathematics should be promoted at all levels and forms.* This should include popularization of mathematics, efficient methods in primary, secondary and college education, modernization of curricula, talent search and nurturing, teacher education, introduction to research and applications, granting of degrees, and a wider recognition and use of modern mathematics in and across various disciplines.

(2) *The program should build on existing strength.* There already are excellent programs in several countries addressing one or the other of the above issues; the Appendix lists some. These provide a wealth of ideas and experience, but there are several obstacles in the way of their widespread adoption. Language, for one, is a barrier for the wide diffusion of educational material. Cultural differences must be seriously taken into account, both as an obstacle to transposing programs from one country to another, but also as a source of richness. Information about the existence of successful programs is at present not easily shared, and many countries lack the financial means to implement them.

(3) *Wherever possible, the program should make use of existing structures and work through established institutions.* Mathematical societies, IMU, ICMI and ICIAM should play an eminent role, as well as the UNESCO category 1 and 2 centers such as ICTP and CIMPA. Regional networks should also be involved and supported.

The role of the UNESCO Program would be to act as a “broker” of programs in mathematical research, education and popularization, developed and tested by local communities. All countries would be targets of these activities, but the main beneficiary would be the developing world, where it should contribute to institutional and individual capacity building in mathematics.

In particular, the Program should:

- Organize and facilitate the evaluation, dissemination, translation, adaptation, and in cases of need, financing the programs.
- Organize and maintain forums for different adaptations of the same program, in the form of conferences, electronic bulletin boards, networks etc.
- Advise governments to support such programs, to introduce more mathematics into elementary and secondary education, to facilitate the recognition and use of mathematics across all the activities of society.
- Conduct large-scale comparative studies extending to many countries of the feasibility and effectiveness of various programs and of the trends in mathematical education and mathematical awareness all around the world.

László Lovász
President of IMU

Michele Artigue
President of ICMI

Rolf Jeltsch
President of ICIAM

Appendix 1: A sample of existing (mostly local) programs

Many excellent programs and ideas promoting the goals formulated in the proposal exist already, and several of these have UNESCO support. Integration through the International Mathematical Program, also with programs developed by other organizations, would initiate many synergic effects, and promote the dissemination of the methods and experiences of these programs, in particular in the developing world.

- ICMI produces well-researched, excellent books on various aspects of mathematical education. The impact of these could be more substantial if they were made accessible to teachers and teacher educators, through translation and dissemination actions, which of course need specific support beyond the publication of the Study.
- IMU and ICMI have a project called "Pipeline", which compares changes in the enrollments to math and math teacher's programs at universities in 7 countries. Results are complex and incomplete, but extending the study to a substantially larger group of countries would require new resources.
- Brazil organizes a mathematical competition with 18 million participants. Other countries have similar competitions, aimed not at the elite but at all students, with a prize system developed accordingly, usually the best students in their school getting prizes.
- More traditional international competitions like the International Mathematical Olympiad for secondary schools students (now attended by more than 100 countries), the International Mathematics Competition for university students, and the Pan African Olympiad for secondary schools students from Africa, have a great impact through bringing together students from many different countries.
- Hungary has a system of mathematical camps for talented children, from the age of 10 and up, with special methods for inspiring inventiveness.
- The US has a program called Research Experience for Undergraduates (REU), which operates in many universities, and introduces undergraduates to the spirit of research through simple but unsolved mathematical problems.
- UNESCO, together with the Centre de Culture Scientifique Technique et Industrielle de la Région Centre-Orléans, Tokay University (JAPAN), Ateneo de Manila University (Philippines), and ICMI, developed a moving exhibition called "Experiencing Mathematics!", which very successfully visited many other countries as well.
- Germany organized in 2008 a "Jahr der Mathematik", with 762 public events and exhibitions in 140 cities, and 4300 exhibition kits distributed for schools. There are similar projects in several countries, like the Millennium Mathematics Project in England.
- The Mathematical Contest in Modeling between university teams has been running in the US for 10 years, bringing mathematics closer to more students through their interest in real world applications of mathematics.
- There are institutions in the developing world where the level of research and teaching matches those at the best universities worldwide. Examples are the Indian Institutes of Technology and the Tata Institute in India, Tsinghua University in China, Instituto Nacional de Matemática Pura e Aplicada in Brazil.
- ICTP (a category 1 center of UNESCO) has organized schools, conferences, supported networks and run a Diploma Programme in Theoretical Physics as well as Mathematics for over forty years. CIMPA (a category 2 center of UNESCO) uses similar means to promote international cooperation in higher education and research in mathematics for the benefit of developing countries.

- Many universities have PhD programs aimed at students from developing countries, designed in such a way as to encourage that they stay in their home country upon receiving their degrees. There does not seem to be a good picture about the effectiveness of these programs.

Appendix 2: Resolution of the UNESCO General Conference on November 11, 1997 launching the World Mathematical Year 2000

The General Conference

- Considering the central importance of mathematics and its applications in today's world with regard to science, technology, communications, economics and numerous other fields,
- Aware that mathematics has deep roots in many cultures and that the most outstanding thinkers over several thousand years contributed significantly to their development, and numerous other fields,
- Aware that the language and the values of mathematics are universal, thus encouraging and making it ideally suited for international cooperation,
- Stressing the key role of mathematics education, in particular at primary and secondary school level, both for the understanding of basic mathematical concepts and for the development of rational thinking,
- Welcomes the initiative of the International Mathematical Union (IMU) to declare the year 2000 the World Mathematical Year and carry out, within this framework, activities to promote Mathematics at all levels world-wide,
- Decides to support the World Mathematical Year 2000 initiative,
- Requests the Director General to collaborate with the international mathematics community in planning the World Mathematical Year 2000 and to contribute during 1998-1999 funds of \$ 20.000 from the Regular Programme and Budget in support of preparatory activities.