Support for Mathematics in Developing Countries

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Introduction. In this short article I will address some issues related to the support of mathematics in developing countries. Of course many of these issues are similar to those facing other scientific subjects, but there are some difficulties special to mathematics. Mathematics underpins all the sciences, both as a language and a way of thinking. It is impossible to adequately address science-related problems facing countries without a solid science and mathematics base. Many of the key challenges facing the planet, for example the prediction and control of the climate, have key mathematical components; these challenges are global, and require global intellectual cooperation. Such cooperation has the important corollary of contributing to peace and understanding between nations independent of their political relations.

Mathematics is highly incremental - you need to master more elementary concepts before learning more advanced ones – and to reach higher levels requires many years of training. Encountering a poor teacher may have a very damaging effect on a student's mathematical education and enthusiasm for the subject. Thus the quality and inspiration of teaching is critical; in particular the training of teachers is a vital component in improving mathematical standards. This is one reason why sequential strategies based on first improving primary, then secondary mathematics etc will not succeed; well-qualified people are needed to train teachers and develop educational strategy. All levels from primary education to research in universities need to be tackled simultaneously in order that mathematics contributes to society in an effective manner.

Developing countries initiatives of the International Mathematical Union (IMU). IMU is the scientific union for mathematics (responsible, for example, for awarding the Fields Medals) The members of IMU are countries; there are currently 68 members, representing a majority of the world's population but a minority of the 193 countries in the world. This is typical of scientific unions, and reflects both the lack of scientific organization in some less developed countries and a feeling (which I do not share) that member countries should have a track-record of mathematical research. A subcommission is the International Commission on Mathematical Instruction (ICMI), with an additional 17 members who are not members of IMU, another the Commission for

Developing Countries. A new class of Associate Membership was introduced in 2006 especially designed for developing countries (with no dues and no vote); so far 4 countries, Ecuador, Kenya, Kyrgyzstan, and Thailand have joined in this category and more applications are under consideration or are being prepared.

Since the IMU income is primarily from the dues of members, the budget for support of developing countries is very small compared to need, about $170,000 annually, including a generous contribution of $45,000 from the Abel Fund. The budget is used to fund a small grant schemes for conferences and research visits, to make a small number of strategic grants, to fund (in conjunction with contributions from national mathematical societies) travel for young and senior mathematicians from developing countries to attend the four yearly International Congress of Mathematicians (in Hyderabad, India, 2010), and to support the Ramanujan Prize for young mathematicians from developing countries (jointly with the Abel Fund and ICTP, Trieste). A recent initiative is the writing of the report, sponsored by the John Templeton Foundation, *Mathematics in Africa: Challenges and Opportunities*, see `http://www.mathunion.org/publications/reports-recommendations`.

A mentoring scheme for Africa. This is a joint initiative of the IMU, the London Mathematical Society (LMS) and the African Mathematics Millennium Science Initiative (AMMSI - see the contribution by Wandera Ogana), funded by grants from the Nuffield Foundation and Leverhulme Trust. The imprimatur of IMU/LMS/AMMSI was essential for convincing the funders that their money would be well spent.

Under the scheme, research groups in Africa are paired with individuals and groups in the UK and elsewhere who act as mentors. The pairing is done following calls for proposals by AMMSI and for mentors by the LMS (on websites, in the LMS newsletter and the IMU electronic newsletter IMU-Net). A key aim is to improve morale and research capability in African Mathematics Departments. African faculty and research students may make short visits to the institutions of mentors, but the idea is to support research groups *in situ* without contributing to a brain drain. So far nine mentoring partnerships have been set up, with three new ones soon to be initiated. Details of the partnerships can be found on the LMS website at `http://www.lms.ac.uk/grants/MARM_projects.html`.

As examples, one partnership is between Frank Neumann, of the University of Leicester, UK, and the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana. The aims and objectives of this partnership are: coordination of research interests for mentoring and collaboration, selection of suitable postgraduate students and researchers, improvement of the local research environment, improvement of postgraduate education, dissemination and exchange of knowledge, and the establishment of permanent national and international research links. A notable outcome of this partnership has been its influence in the selection of KNUST as the location for the new National Institute of Mathematical Sciences (NIMS).

Another partnership is between Nigel Cutland, of the University of York, UK, and the Bahir Dar Universty, Ethiopia, an aspiration being the launching

of an MPhil/PhD programme in order to upgrade staff. The department at Bahir Dar University suffers from problems typical of universities in the developing world, such as minimal library resources, with many texts photocopied, very poor internet, large teaching loads (more than 12 hours per week), and a lack of research leadership.

Developing mathematics in Tibet. I have visited the Department of Mathematics at the University of Tibet in Lhasa three times, in 2002, 2005 and 2009, and am currently supervising a research student fron the department in Oxford. With help from the Chinese Mathematical Society and the China Association for Science and Technology, I have tried to help the Department develop a plan of action to improve the research and teaching quality. Tibet University faces many difficult issues, including geographical isolation and a harsh physical environment (the altitude of Lhasa is 3650m). Despite an attractive new campus the facilities are poor in comparison with many universities in mainland China. There is no significant research tradition and it is difficult to attract well-qualified faculty even with enhanced salaries. About half the undergraduate students are Tibetan and half from mainland China, with corresponding differences in background and native language, but working harmoniously together. The undergraduate degree is designed exclusively for the training of school teachers. Funding for research training and travel to conferences etc is negligible.

Some of these problems are not unique to less developed parts of the world and not quick to solve; we all know how difficult it is to introduce a research culture into a department that does not have one. One possible way to accelerate the process could be to establish a link with a stronger department in mainland China which can act in a mentoring capacity and help train young faculty. Another is to take advantage of video-conferencing technology to access courses and seminars and conduct remote research supervision, thus mitigating the effects of geographical isolation, a possibility made all the more practical since China has a single time-zone. Of course all this requires appropriate funding. The undergraduate course could be broadened so that it trains mathematicians who will be useful to society in different ways, not just as school teachers.

Citations and impact factors. There is a worrying trend throughout the world for university administrators, government funders etc to rank the research of departments and individual researchers by seemingly objective metrics such as numbers of citations and the impact factors of journals where their papers are published. It seems that this trend is accentuated in some developing countries, where its effects can be more serious due to the smaller size of the research base. In some countries salary is affected by such metrics, while I have heard of one university in a relatively prosperous though underdeveloped country that seeks to improve its research rating by hiring to part-time posts highly-cited researchers, by this means acquiring their own share of the citations of these researchers. Numbers of citations, impact factors etc are statistics, perhaps valuable if intelligently used in the evaluation of large units, such as universi-

ties or large departments, but dangerous when applied to individuals. (See the 2008 *Citation Statistics* report of IMU/ICIAM/IMS; `http://www.mathunion.org/fileadmin/IMU/Report/CitationStatistics.pdf`.) It is what you write, and what top researchers think of it, that really counts, not where your paper appeared or its general popularity; deep work may be unappreciated for some years except by a few experts capable of understanding it.

Concluding remarks. Mathematical talent does not respect geographical or political boundaries, but the opportunities to develop it vary widely depending on where you live. Schemes to nurture such talent should involve cooperative planning with subject leaders in the developing country concerned (thus respecting local culture and conditions), and should avoid externally imposed solutions. Talented individuals should be identified, supported and rewarded through long-term programmes. An important resource comprises (especially young) academics in the developed world, who should be encouraged to regard it as part of their duty to share knowledge and experience with those who have less access to facilities and advice.

As discussed at this conference, thematic networks are an excellent way to increase critical mass and morale. The internet has essentially removed the problem of access to information, given a suitably fast connection (however, being trained to use this information is a different matter). As internet connections improve live video-conferencing becomes an increasingly attractive possibility for sharing courses and seminars between regions on similar time-zones, in particular increasing the effectiveness of thematic networks.