Mathematics & Sciences in the emerging economies - impressions from a roundtable at ECM6

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Following roundtables at ICIAM 07 in Zurich, and ECM5 in Amsterdam 2010, a third discussion about mathematics in the developing world was held at ECM6 in Krakow, in July 2012.

The five BRICS and beyond

This time the emphasis was on the emerging economies, as exemplified by the so-called BRICS countries: Brazil, Russia, India, China, and South Africa. They total about one fifth of global GDP and close to half the world's population estimated as 7.023 billion by United States Central Bureau. Despite repeated efforts, the organizers could not secure the participation of a Chinese researcher at the round table. Fortunately, Prof. Tsou Sheung Tsun of Oxford University who co-moderated and Prof. Jin-yun Yuan from the Federal University of Parana Brazil are of Chinese origin and have kept up to some extent with the developments there. The remaining three BRICS were represented by Professors Alexander Shananin from the Moscow Institute of Physics and Technology, Neela Nataraj from the Indian Institute of Technology Bombay, and Gareth Witten from the University of Cape Town. Moreover, we welcomed Prof. R .Enkhbat from the university of Ulan Bator, the urban center of the resource rich Mongolia, whose economy had grown by 14 percent in the previous year. Such explosive emergence is probably not sustainable and is in this case clearly not based on knowledge based industries. As stated by Enkhbat, Mongolia spends only 0.2% of its GDP invested Science and Technology, a fraction of most countries in the world spend, be they developed or not.

Confidence and brains are coming back

Looking back to report on the ICIAM round table in the March 2008 edition of SIAM News, one can notice some striking changes. Then and now, for the majority of developing countries, brain drain has been a major concern. That is no longer so for the emerging economies, with the notable exception of Russia and to a lesser extent Mongolia. In the other four BRICS 'Brain circulation' seems to work increasingly well. More specifically, the emerging economies are now able to re-attract young researchers who have gone to the industrialized North by providing reasonable salaries and acceptable working conditions. As discussed at the round table that applies not just to universities, but also to industrial employment. At least in Brazil, Mongolia, and Russia there are government schemes which lure people who have excelled outside back into the country. This reverse flow had been predicted at the Zürich meeting by Prof. Persens from South Africa, which also attracts a lot of talent from the neigboring countries in Sub Saharen Africa. More or less, the same applies to Brazil, but little to the three enormous asian BRICS, which comes as a surprise. They are surrounded by a few and rather small countries, which were often alienated through the legacy of previous political and cultural domination. Even though this may be partly a matter of perception and will hopefully overcome by future generations, the leading institutions in emerging economies cannot naturally radiate as centers of scientific excellence beyond their borders, but rather within.

The internal divide

The noticeable improvement in the relative scientific standing of some emerging economies does not mean that all is well. These gains are concentrated only in a few leading institutes in some advanced regions, like the coastal plains around Sao Paulo and Rio de Janeiro in Brazil, the metropolitan areas around Bangalore, Chennai, Delhi, Kolkata and Mumbai in India, the traditional urban centers Moscow, St. Petersberg, and Nowosibirsk in Russia, the Western Cape province in South Africa and the regions around Beijing and Shanghai in China. Much of the remaining countryside remains firmly at the status of developing countries, with talented youngsters migrating to the centers if they are discovered and educated at all. The urban-rural divide in China is quite prominent with the proportion of rural students going to high school being significantly less than that of the urban counterparts.

Secondary schooling especially in mathematics and science is usually at

a very poor level especially in the country side with teachers being haphazardly prepared and motivated for their job. Moreover, in many places, the subjects are taught in local languages with the faculty members following sub-standard text books and not exposing the students to good literature even at the college level. Gareth Witten pointed out at the round table that approximately 40 % of the students in South Africa don't study Mathematics at the secondary level as it is not a compulsory subject. Generally, the level of schooling is very poor, both with regards to the percentage of young children attending classes and with respect to content and didactics.

As stated by Neela Nataraj, most girls in India do now get at least some basic education but their retention rates are smaller and their number drops off compared to those of the boys at every transition to higher level of education. Especially at the university level that is also familiar from developed countries, but in the developing countries, including the bulk of the emerging countries the social obstacles are particularly strong. More specifically, the prevailing Western model of marrying after finishing once university education remains at a strong variance with the cultural traditions and practices outside the metropolitan centers in the non western countries.

Typically the majority of faculty at departments of mathematics and statistics hold only Master degree, while PhDs are few and far between and full professors, rare exceptions. On the other hand, it is of course recommendable that most places seem to resist the temptation to simply lower the standards for professorial appointments. In each of the BRICS countries there are usually one or two universities that are listed amongst the first few hundred universities in the Shanghai ranking and other global listings. On the other hand, there is a large growth of lesser universities and colleges, many of them private, that offer primarily mid-level technical qualifications and management degrees. The total percentage of young people receiving some sort of tertiary education in the BRICS seems to hover about ten percent (14.6 in Brazil) and is thus still much smaller than in the developed countries, where sometimes 50 percent fall in that category. A steady growth in that segment can be expected in the emerging countries and the developing world in general.

This internal divide, specifically in the BRICS countries is also a minor difficulty for IMU, ICIAM and other professional societies when they try to restrict their scarce resources for international cooperation to truly developing countries. Is the colleague from Rio de Janeiro still more deserving of a travel grant than a colleague from Thessaloniki? Probably not, though Greece is not yet on anybody's list of a developing country.

Transformation of systems and values

Traditionally the situation in Russia and Mongolia was somewhat better, since the Soviet system placed great emphasis on mathematics and the natural sciences throughout the school and university system. Both educational systems are undergoing dramatic transformations, after the traditional strength especially in the tertiary sector has been eroded through the emigration of senior faculty to the West. The following generation is almost completely lost to mathematics and science as for nearly two decades there were no scholarships and junior positions with sustainable salaries, a situation that is only gradually improving. In particular, Mongolia tries to get some of the young people back by offering high salaries.

Like in other former soviet republics and satellites there is partly the perception that the hard sciences are somehow old fashioned and all the excitement lies in modern 'Western' fields like law, economics, and the social sciences, which were hitherto tightly controlled and could only be taught within the narrow perimeters of Marxist orthodoxy. At least as far as economics and finance is concerned some of the enthusiasm would have worn off by now. However, like in the West and even African countries there is the perception that more money can be made in nonscientific professions, especially in the domains of law, the media, and business in general. This notion is particularly firmly entrenched in American popular culture, although it has recently been debunked by a survey on career paths http://www.careercast.com/jobs-rated/10-best-jobs-2011. There, the five top ranks were all awarded to 'geek' professions based on mathematics and computer science. At least in India, a technical education, preferably capped with a management degree and employment in a multinational corporation is generally valued higher than a strictly commercial career, which is tendentially associated with shady dealings and wheelings. Our geeky IIT graduate will then also rank quite well in the matrimonials, when parents or relatives feel it is time to marry him or her off.

Individual Careers and Key Technologies

For an academic career, a longer stay abroad is almost inescapable for Indians. The main benefits are a higher income in comparison to the Indian post-doc salaries and academic exposure leading to better publications. Also they hope for better job prospects in India after their return, especially after the sudden boom in the education sector in the recent past. Again it must be noted that the large majority of girl students do not really venture into going for a doctoral or post-doctoral position due to social and cultural

constraints.

In Brazil, there are plenty of opportunities for graduates in mathematics and sciences, both in the private sector and the universities, where a fresh Professor with a PhD gets 13 salaries of R$6500 after tax per year. There is extra money for travel and a guaranteed raise after a year, but still many positions remain unfilled. In contrast, South Africa offers only a few, highly contested academic positions but there are many opportunities in the private sector and public administration, where non-whites can receive some preferential treatment through black empowerment programs. Mining companies, banks, IT companies, economic research centers and other industries offer jobs for mathematicians in Mongolia. The government of China has taken up the task of tempting emigrated talent to return home. As reported by " The Christian Science Monitor", (Oct 21, 2012 issue), the government plan offers top scientists and high-tech entrepreneurs $150,000 in cash, free office or lab space, housing allowances, and fast tracks into good schools for their children to attract them back into the country.

Irrespective of the country, the industries where Mathematics either plays a role or has a potential to play a role are service industries where Operations research plays a cruical role and information technology industry, where combinatorics & optimization techniques are applied. The role of Probability & Statistics is well-recognized in Financial Mathematics. This area continues to provide significant employment, despite the crisis of 2008, which is partly blamed on poorly understood quantitative modeling. Manufacturing industries is an area where the potential of Mathematics has not been fully utilized unlike in Western countries, for example for aero space and automotive engineering. Lastly, the recently recognized role of Mathematics in the biological & environmental sciences provides many opportunities and its full potential is yet to be realized.

Clouds on the horizon

We use here the 'northern', ominous interpretation of the cloud metaphor, even though in tropical countries like India and Kenya clouds on the horizon may represent a ray of hope promising the long awaited end of the dry season. The advances of the BRICS has been helped by the fact that the established economies have suffered a bit of submergence in the financial crisis that broke out in 2008. While it no doubt effects economies world wide the BRICS states were better able to whether the storm and some were able to make relative gains.

In contrast, in the US and Europe public and private institutions of

higher learning suffered budget cuts and endowment devaluations, which adversely effected hiring and working conditions at universities and research laboratories. Moreover, rising unemployment tends to reinforce public hostility towards foreigners, especially from the South, who were already viewed with suspicion on supposed security grounds since September 11, 2001. Generally, scientific exchange continues to be inhibited by strict visa requirements and complicated immigration procedures, which were typically first imposed by the North and then reciprocated by the South in a tit for tat fashion, as for example between the US and Brazil.

This situation is acerbated by the fact that the NATO countries have always viewed not only Russia but also its traditional South Asian ally India as adversaries when it comes to military or dual use technology. Now this worry has grown dramatically with respect to China and to a lesser extent to Brazil, which has also become a major weapons and aircraft exporter, apart from asserting its independent foreign policy role in the Americas beyond. So there is a real danger of a segmentation into four or five closed camps, where travel, scientific exchange and even internet communication are again severely limited by mutual suspicion and power plays. When there is any involvement of defense related institutions visa approval times might stretch from three months to infinity.

While South Africa and Brazil are a bit on the sidelines, it goes without saying that Russia, China, and India also treat each other with considerable caution, despite punctual collaborations in various fields and even on weapons systems.

Scientists and world citizens of all stripes should strive to avoid these retrograde tendencies in favor of an open multipolar world with free flow of people and information.

Reasons for optimism

People engaged in advancing global cooperation in mathematics and sciences are often frustrated by the experience that national authorities seem notoriously unwilling or incapable to make any sustained contribution to the development of an educational and scientific infrastructure in their countries. There is a mathematical master program in a developing country that has been sustained for seven years by CIMPA and other organizations, which now in the danger of collapsing since the nation does not feel obliged to take over funding and responsibility to any significant extent. In contrast, the BRICS states and most other emerging economies governments appear to realize that closing the gap to the developed countries cannot be based on a resource driven economy at all, but must be sustained through

better public education, and ones own research infra structure.

More specifically, the BRICS states have formalized their cooperation over the last five years, with the last annual summit meeting held in Durban, South Africa at the end of March 2013. The discussions and decisions at the summit were mostly concerned with economic issues, such as the establishment of a development bank. However, the preceding academic forum suggested amongst four other recommendations that: 'BRICS should intensify its support for collaboration amongst academics and scholars through a variety of institutions, networks and programs that advances education, research and skills development.' And furthermore: 'BRICS should consider the establishment of an independent BRICS rating agency for educational institutions as well as a BRICS university.'

In view of the growing quantity and quality of South-South interactions we can conclude that the interpretation of global scientific collaboration as an arena of slightly patronizing Western largesse is becoming rapidly outdated.