

# Round Table at 6<sup>th</sup> ECM : Role of Mathematics in Emerging Economies 5 July 2012



Emerging markets are nations with social or business activity in the process of rapid growth and industrialization.

- Emerging countries are playing a growing role in the world economy. It is a role that is expected to be even greater in the future.
- Argentina, Brazil, China, India, Indonesia, the Russian Federation and South Africa form the group of the worlds largest emerging economies.
- At a time when restoring sustainable growth after the Great Recession is a key priority, they are playing a very crucial role in supporting the global economy.
- Academically emerging countries have or develop the capability to sustain a significant number of graduate programs and to offer some of their citizens in Western institutions attractive positions to return home.

## Coordinators

- Andreas Griewank (Humboldt University, Berlin)
- Tsou Sheung Tsun (University of Oxford)

## Panelists

- Neela Nataraj (Indian Institute of Technology India)
- Enkbhat Rentsen (National University of Mongolia)
- Gareth Witten (University of Cape Town)
- Jin Yun Yuan (Federal University of Parana)

- 1 Numeracy
- 2 Tertiary Education
- 3 Rankings & Accreditation
- 4 Individual Career of Math Graduates
- 5 Research Culture
- 6 Mathematics as Key Technology

# NUMERACY-ELEMENTARY EDUCATION

- Lower secondary level (grades nine and 10), enrolment rate is 52%, free and compulsory education to children of ages 6 to 14 (estimated to be 205 million in number) a fundamental right, Science and Mathematics compulsory.
- Senior secondary level (grades 11 and 12), enrolment rate is 28%.
- 48 % drop out rate due to socio-economic reasons (especially states like Bihar, UP etc);
- Infra structural issues (drinking water, buildings).

- **Girls drop out of school.** There is a wide gender disparity in the literacy rate in India: effective literacy rates (age 7 and above) in 2011 were 82.14% for men and 65.46 % for women.
- The low female literacy rate has had a dramatically negative impact on family planning and population stabilization efforts in India.

Existing schools with inadequate teacher strength are provided with additional teachers, while the capabilities of existing teachers is being strengthened by extensive training under the Sarva Shiksha Abhiyan (The Education for All Movement).

- Every year 30,000 pupils finish their secondary schools in Mongolia.
- 60 % of them enroll universities and colleges.
- Mongolian national school curriculum (contents) is 1.5 large than Cambridge International Secondary and Russian curriculums.



# NUMERACY-ELEMENTARY EDUCATION : MONGOLIA (Continued..)

- 61 countries have been selected for comparison of their curriculums.
- Mongolian school average curriculum is 2 times bigger than international average standard.
- Since 2011 several Mongolian schools have been chosen experimentally for launching [Cambridge International Examination](#).
- Mathematics curriculum constitutes 10-12 % of total curriculum in state schools while it is 50 % in private secondary schools. Since 2015, Mongolian national Curriculum will switch to Cambridge International secondary curriculum.

# NUMERACY-ELEMENTARY EDUCATION : BRAZIL

- The status of basic education in mathematics and sciences is, in general, disastrous.
- Mathematical illiteracy is generalized. Qualification of teachers is very low.
- Totally 50 millions students at elementary and secondary schools. 98% children between 7 and 14 years get into schools. Only 14.6% of students can get opportunity of study at college or university. 11% can get university degree (government), but 8% (private survey) Totally 5.92 millions students. Among all students, only 15% for Sciences, Technology, Education and Mathematics.

# NUMERACY-ELEMENTARY EDUCATION : SOUTH AFRICA

- 12 % of Grades 6 (10 year olds) pupils scored 50 % or more in Mathematics.
- 40 % of High School students were not taking Mathematics at all.
- 5 % passed Mathematics in the Matric Exam.

# TERTIARY EDUCATION

- Pressure from Industry for relevant Mathematics and Numeracy.
- Funding for Pure Mathematics under pressure.

# TERTIARY EDUCATION : BRAZIL

- Out of 50 million students, 14.6 % attend University and Colleges.
- 2378 University and Colleges where 278 are public, rest are private.
- 15 % undergraduate courses are on Engineering and Sciences.
- 35 % students study administration, law and education.

# TERTIARY EDUCATION : MONGOLIA

- In Mongolia there are more than 114 universities and colleges.
- 7 universities are state and the rest of them is private.
- 90 % of universities are business and economics colleges.
- The main university is National University of Mongolia which has more than 20,000 students and 1200 teaching staff. The university is ranked in 2500 among 6000 world universities.
- All economics students learn calculus & operations research.

- School of mathematics and computer sciences has 200 students and 60 teaching staff.
- Curriculum of mathematics has changed much at Economic Schools since 1990 in order to meet societys demand.
- Mongolia has made an economic transition from centralized and planned economy into market economy.
- New subjects such as Mathematical Economics, Game theory, Microeconomics and Macroeconomics have been added to the university curriculum in order to understand market phenomenon.



# TERTIARY EDUCATION : INDIA

- Technical education has grown rapidly in recent years.
- nation graduates over 500,000 engineers (with 4-yr undergraduate degrees) annually,
- In addition, the nation graduates over 1.2 million scientists.
- India's annual enrollment of scientists, engineers and technicians now exceeds 2 million.
- There are more than 690,000 students of science and maths graduating every year - much higher than China, Japan, the US and Europe.
- As of 2011, India has about 500 universities, 5 institutions established and functioning under the State Act, 16000 colleges as Government Degree Colleges and Private Degree Colleges, and 33 Institutes of National Importance.

# RANKINGS & ACCREDITATION

# RANKINGS & ACCREDITATION : BRAZIL

- University of São Paulo (USP) is the best university in Brazil, ranking well (200).
- State University of Campinas (UNICAMP) also is very good university.
- In Mathematics, IMPA is the best institute (better than USP), USP is the best university in Pure Mathematics, and UNICAMP is the best one in Applied Mathematics in Brazil.

The CAPES evaluate all undergraduate years and approve new programs and finance.

# RANKINGS & ACCREDITATION: INDIA

- The Indian Institutes of Technology (now 15 in number) were placed 50th in the world and 2nd in the field of Engineering (next only to MIT) by Times Higher World University Rankings.
- Indian Institute of Science is the premier research institute in the field of science and engineering.
- the Indian Institutes of Technology (IITs), Indian Institutes of Management (IIMs), Indian Statistical Institute (ISI), National Institute of Technology (NITs) and Jawaharlal Nehru University have been globally acclaimed for their standard of education.  
However, India is well behind world class universities like Harvard or Oxford.

There is a network of research institutions that provide opportunities for advanced learning and research leading up to a Ph.D in branches of science, technology and agriculture.

Accreditation for universities in India is mandatory by law unless was created through an act of Parliament.

# RANKINGS & ACCREDITATION : SOUTH AFRICA

- South African universities are ranked highest in Africa and top 100 in the world (FT, The Economist etc).
- Universities use the ranking agencies to allocation of resources in order to improve rankings, attract students and faculty and compete with other universities.

# INDIVIDUAL CAREER

# INDIVIDUAL CAREER : MONGOLIA

- Mining companies, banking, IT companies and Economic research centers, also some industries offer jobs for mathematicians.
- Young scientists have high priority to get jobs in Mongolia. The government invites them to return to the country and promises high salary.

# INDIVIDUAL CAREER : BRAZIL

- Offer scholarship for students who study in Brazil or abroad without TA and RA work (R\$1400 for master program, R\$2000 for Ph.D. program tax free).
- The initial salary is R\$6500 per month after tax, and 13 month salaries per year for fresh professor with Ph. D. degree.
- There are Research programs for fresh Ph.D. such as young researcher program etc.
- Every year, researchers can get one chance to participate international congress abroad.
- Every two years, the salary will be promoted one level up. Young researchers can apply for research fellowship 3 years after getting Ph.D. degree., Also can apply for Post-doc fellowship to do Post-doc in other country.
- Many open positions for faculty positions in Mathematics.



# INDIVIDUAL CAREER : SOUTH AFRICA

- Few graduates stay on to follow a career as a mathematician as they compete for positions with global scholars who the universities attract for rating positions.
- Most mathematics graduates go into industry sectors, mostly finance.

# INDIVIDUAL CAREER : INDIA

- The good students prefer to go abroad for post doctoral fellow positions.

## Reasons:

- i) high salary (in comparison to Indian salary),
  - ii) exposure (better opportunity to work with reputed scientists),
  - iii) good publications.
  - iv) better job prospects in India - Education sector is having a boom period with 15 IIT's, 5 IISER's, NIT's, IIST etc.
- Take up academic positions in India (private Science and Engineering Colleges)- Salaries have improved since last 6 years and retirement age is 65.
  - Joining private companies or government jobs (arrests their further development in research).

## Pursue a post doc in India - (last option)

- quality of research in most of the universities in India is not up to the right standards;
- priority to settle down in life with a permanent teaching position which is easier with the boom in the education sector,
- in universities/institutes priority for teaching takes over research.

Majority of girl students don't really venture into going for a doctoral /post-doctoral position due to social & cultural reasons.

# RESEARCH CULTURE

# RESEARCH CULTURE : INDIA

- Research grants available for Mathematicians.
- Not enough motivation for academicians to pursue research.
- Permanent job positions do not demand any requirement to continue research.

Can the country offer attractive positions for a young mathematician/scientist doing well in the West? **NO**

- The average salary for a starting position (Assistant Professor position after 3 years of postdoc) is about 1200 dollars per month along with some basic medical/ housing facilities.
- Most of the institutes are not located in metropolitan cities.
- Metropolitan cities are expensive and a young mathematician from a Western country may not find it affordable.
- Quality of research is another important factor.

# RESEARCH CULTURE : BRAZIL

- There is not really emphasis on applied mathematics. People just use applied mathematics to justify the necessity of research funds from the government. Discrimination on applied mathematics is still serious problem.
- Industry does not trust neither believe that mathematics can help them. They do not want to put money on mathematics research. Personal influence is main factor to get research funds from industry.
- At energy area, the government has law to force them to invest 1% of their gross income to research, development and innovation. But the money in Mathematics research and applications is still very little. Mathematicians must have capacity of negotiation and patience with engineers and companies.
- Recently industrial mathematics becomes fashion in Brazil. Industries are interested mathematicians to help them to do innovation. The government also supports all innovation projects.

- The federal government and state government invest 1.4% of their GDP in Sciences and Technology research.
- In this sense, FAPESP has much more money than other states. In Brazil, the progresses in Sciences and Technology are concentrated on the states São Paulo and Rio de Janeiro. In whole country, most research funds are distributed in this region.

# Special Grants in Brazil

There are good grants from the governments, especially in São Paulo. In general, Industry does not provide any grant.



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# Special Grants in Brazil

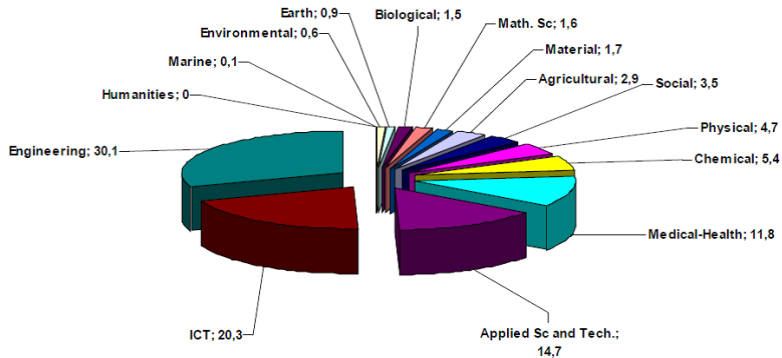
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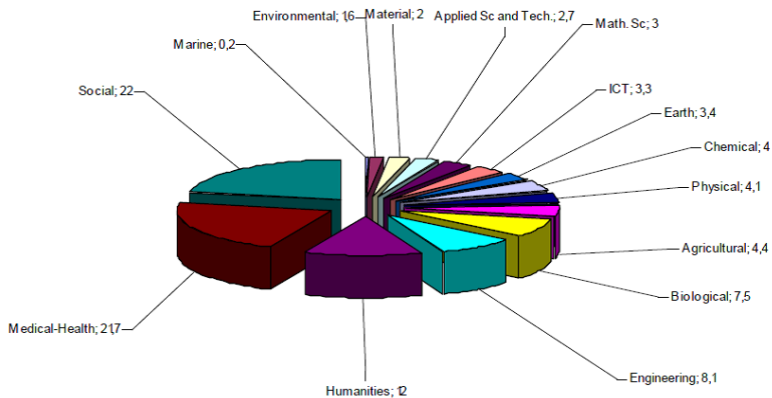
**OBMEP:** Mathematics Olympiad for Public Schools (OBMEP) is organized by IMPA with 19 millions participants each year to find talents on Math and to improve mathematics ability of students in public elementary and secondary schools. The program offers scholarship for 3500 selected students for whole year with extra directed math study, also for some undergraduate students and graduate students. We like to prepare good students for Sciences and Technology.

# RESEARCH CULTURE : SOUTH AFRICA

Business R&D Expenditure by research field, 2007/08



## Universities R&D expenditure by research field, 2007/08



- Mongolia is rich in resources. Economic growth for the first half of 2012 is 17.2%.
- But only 0.2% of GDP is devoted to Science and Technology which is 5 times less than Russia and 7 times less than China.
- Institute of Mathematics was established in 1973 as a part of Academy of Sciences of Mongolia. Mathematical research in Mongolia is concentrated in the Institute of Mathematics(IM).
- In 1997, during transition period, IM was transferred to National University of Mongolia.

- IM has pure and applied mathematics divisions and about 40 academic staff. Most of researchers of IM teach at the School of Mathematics and Computer Sciences of the University as part time employees.
- Total Ph.D holders of IM and School of Mathematics are 50. IM is financially supported by Mongolian Science and Technology Foundation for their approved projects.
- IM regularly organizes international seminars, workshops and conferences and publishes its Mongolian Mathematical Journal. IM every year publishes 4-5 papers in SCI and SCIE journals.

# MATHEMATICS AS KEY TECHNOLOGY

The industries where Mathematics plays a role/ has a potential to play a role

- **Service industries** - Marketing, Role of Operations research.
- **Information Technology industry** - Combinatorics, Optimization techniques are applied
- **Financial Mathematics** - Role of Probability/ Statistics is well-recognized , need to do a good Mathematical modelling and satisfy the demands of accuracy in the real time calculations.
- **Manufacturing industries** - Potential has not been fully utilized unless in Western countries eg : Volkswagen - auto industry , Aerospace industry.
- The role of Mathematics in the **biological & environmental sciences** provides many opportunities and its full potential needs to be realised.

Thus emerging economies present a very interesting scenario to mathematicians in terms of their capacity to meet challenges in different sectors to achieve the desired objective of employing the mathematical theory and techniques to solve the problems of national importance.



Do we understand the role of mathematics in an emerging economies?

- Applied Mathematicians/ Practitioners are less in number.
- Mathematicians are unaware of the cutting edge problems in industry.
- Lack of experts in Mathematical Modelling.
- Lack of experts in Mathematical Sciences to address the different real economic and geographical challenges.

# How to overcome the challenges?

- Interdisciplinary research among the scientists
- School level - Application oriented Mathematics
- Under - Graduate level Research suggests that engineering education would be enhanced by the addition of courses in accounting,  
finance,  
marketing,  
organizational behavior,  
commercialization of technology  
and strategy.
- Promote interdisciplinary degrees in engineering.
- Graduate level- Train more mathematicians in applied and interdisciplinary Mathematics.