Undergraduate Math Education

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Undergraduate Math Education in India

India is a country with a population of over 1.2 billion people – only a tiny fraction of the Indian population enters higher education – it is yet vast in numbers, and expanding rapidly. The immediate twin challenges that the country faces are:

How do we increase the percentage of the population that accesses higher education? And how do we improve the quality of higher education?

Given the vital importance that undergraduate mathematics education occupies, it is necessary that we examine the doctrines that govern undergraduate mathematics education in India.

What institutions or courses comprise undergraduate mathematics education?

What should be the aims and goals of undergraduate mathematics education?

What is the state of undergraduate mathematics education in our country?

Are our courses geared to meeting the stated goals and aims?

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Some Goals of Undergraduate Mathematics Education:

* Create a pool of future mathematicians and mathematics teachers.

* Graduates should also have

  * a knowledge of society
  * ability to Communicate
  * ability to work in a team
  * ability to use modern tools like computers and computer networks.
  * ability to apply mathematical techniques to analyse, model and solve problems.

* Unfortunately, these goals are not being met to the extent required. We are neither producing the number of mathematicians required of good quality, nor are we able to inculcate the kind of skills required in a graduate of mathematics.

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Type of undergraduate programmes:

* 3-4 year Honours programmes (about 2/3rds weightage is for mathematics)
* 3-year BA/ BSc programmes (about 1/2 to 1/3rd weightage is for mathematics)
* Bachelor's degree students of Physics, economics, Engineering, Commerce would also study a few courses in mathematics

Possible causes for concern:

* Curriculum and Pedagogy
  - Syllabus in 1950 and 1960s
  - Syllabus reforms (1970s onwards)
  - University Grants Commission (UGC) Model syllabus
  - Assessment
  - Use of IT
* Pre-service qualifications and in-service training
  - National Eligibility Test (NET)

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Syllabus:

In the 1950s and 60s mathematics curriculum was very narrow. The text books used seem to have been those published at the turn of the 19th-20th century.

Syllabus reforms took place from late 60s and 1970s onwards with the introduction Real and Complex Analysis, Abstract Algebra etc.

The UGC created a Model syllabus for UG and PG level in 2001.

*Books recommended are a mix of modern books but also some used in 60s
*UGC recommendations seem to have failed in giving a leadership in terms of applicability of mathematics, the use of IT in mathematics

Use of IT in mathematics teaching very minimal, seems to have by-passed the vast majority of such programmes across Universities in India.

Use of spreadsheet programmes, CAS etc missing from most.

Programming, Modelling and infering missing from most.

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Pedagogy: Most alarming situation on average

Teaching = Demonstrating Content = State and Prove

Minimal student interaction, learner mostly passive

Objective is to prepare learner for an assessment which only requires reproduction from memory

Students are not taught to think, analyse and solve problems

No good pre-service training or inservice training available for faculty to learn about teaching methods and tools.

Assumption is that qualifications are enough to ensure quality teaching

No method in place to analyse quality of teaching

Exams and assessments are mainly summative and good memory equals high scores

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Assessment: Plenty to think about and change

Assessment plays multiple roles:

Guiding the teacher on the manner in which students have learnt what has been taught

Guiding the student on the extent to which she is making progress

Guiding a future teacher and/ or employer on what knowledge and skills have been acquired

The last role, with an emphasis on marks and grades, tends to become the primary focus for students.

Subsequent admissions or employment seem to be directly dependent on these.

This should and could be exploited to help achieve stated goals for undergraduate math education.

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Lack of well-qualified, motivated faculty is a major problem:

To teach at UG level qualification required is Masters with NET

In better institutions many faculty members will have MPhil, but very few Phds

Quality of MPhil and PhDs is very worrying. Deep disconnect exists between degree and knowledge.

Faculty are mostly unaware of good use of IT, programming etc

Not enough incentives-disincentives in the system to motivate faculty to improve qualifications

Many efforts are being made to strengthen tertiary mathematics primarily through activities funded by the National Board of Higher Mathematics for high school students, undergraduates, postgraduates, researchers and faculty members.

Conclusion

About 400 Universities and 18000 colleges offering UG courses in mathematics.

Number of PG students in mathematics is around 25,000.

Number of MPhil/ PhD in mathematics is in the range of 800-1000.

About 30,000 teachers work at the undergraduate or post-graduate levels.

It is clear that for a country that is making great strides in many fields, the lack of an educated work-force will prove to be a huge speed-breaker.

India can be rightly proud but at the same time cautious:

* **Undergraduate mathematics curriculum has broadly kept up with international standards. Students have better access to books, computers etc.**
* **On average, faculty is better qualified than fifty years ago.**
* **In urban centres, half the mathematics class is usually women and this ratio improves further in taught post-graduate courses in mathematics.**
* **However, the teaching-learning process at the undergraduate level is not even meeting what should be its minimum goals.**

Conclusion

Two Major Failures:

Not really equipping and training the minority that plan to take up a career in mathematics, research and education.

The majority are neither gaining any understanding of the role of mathematics in society nor are they learning the skills required by all in terms of communication, presentation, or the use of modern computer technology.

Possible Solutions:

We need to create a syllabi that through its content, recommended books and resource material would make learning mathematics meaningful in more ways than one.

Improved qualifications, focused in-service training for faculty particularly in terms of familiarity with programming and use of mathematical software need to be instituted.

Improved infra-structure, and well conceived schemes of both incentives and disincentives need to be instituted.

Conclusion

Possible Solutions:

It should be possible to create assessment scenarios, which make sure that grades and marks are linked to actual learning and ability to apply the concepts learned.

Specifically, assessments should be used to guide a multi-tier/multi-stream approach to undergraduate education without attaching a stigma of failure to those in the slower streams (or a misplaced sense of achievement among students placed on faster tracks!).

Systemic Changes Required:

Schemes for strengthening tertiary mathematics need to be scaled up and need to spread to smaller towns and rural districts.

Special attention also needs to be given to attracting more students and also more women students to research.

The existing hierarchies in education have created compartmentalised discrete structures that mitigate against continuous flow of information and ideas between different levels of mathematics education.

Conclusion

Systemic Changes Required:

There also seems to be almost no data capturing the state of undergraduate mathematics education.

Serious study needs to done on quality of MPhil and PhDs

There is no significant research undertaken about undergraduate or tertiary mathematics education.

The community of mathematicians and mathematics educators in India seem to inhabit separate worlds.

Improvement just at the undergraduate or tertiary level is not enough. The entire community needs to focus on improving mathematics education at all levels.

Seminars, conferences and research can go a long way in creating the necessary paths that lead to a better understanding of the problems.

It will also help in framing policy that will hopefully pave the way and provide the right setting for the solutions to take root.