

THREE EXPERIMENTS IN TEACHING UNDERGRADUATE STUDENTS IN MATHEMATICS

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ABSTRACT

The aim of this presentation is to describe the pleasures and the problems in teaching undergraduate students. We look at three experiments. One experiment looks at the methodology of teaching a large class of 250 students using the overhead projection method. The advantages/disadvantages of this method from the viewpoints of students, teachers and the administration are discussed. The other two experiments look at teaching a class size of about 40 students in an examination free set up, in a more interactive way. The feed back of the students about the several aspects of these methods are discussed.

Experiment 1: Teaching a large class

Introduction

This is the experiment carried out at Indian Institute of Technology Bombay (IITB) from 1997-2000.

At IITB, about 450-500 students are admitted every year to various engineering programs. All the first year students are given core-courses, one each in Mathematics, Physics and Chemistry. Till 1997 these students were divided in 4 divisions, each division assigned to a teacher – one of them being the instructor-in-charge, for coordination of the course. The method of teaching was the traditional ‘blackboard-chalk method’. In 1997, for various reasons, it was decided to undertake an experiment of teaching large classes (of the size of 250 or so) with the help of ‘modern technology’.

Methodology

The methodology proposed to conduct the course was the following.

In view of the large class strength, the traditional blackboard-chalk method of delivering instructions has to be replaced. It was proposed (in fact that is what was finally implemented) to use overhead projection of instructions. Also to have uniformity (across different divisions) it was felt desirable that the same material be used in all the divisions. Moreover, since the place of instruction has to be dimly lit (to make the overhead projection effective), it was felt that the student would find it difficult to take notes during the lecture. Thus a ‘concise’ set of notes needs to be prepared for the students.

To implement this, a team of two instructors (one for each division of 250 students) was selected about 3-months before the start of the course. They achieved the required preparations, see [2], and the course was conducted in 1997. The experiment was repeated in 1998 and 1999. In all these experiments, conducting a class meant explaining (to 250 students seated in a dimly lit hall) mathematics from a set of notes projected on a screen.

I will list below some of the advantages and disadvantages of this method of instructions (see also [1]).

Advantages

(i) From administration point of view

- Large number of students can be taught with lesser faculty.

(i) From the teachers point of view

- Teachers have sufficient time to plan, discuss and prepare the course in advance.
- During the lecture the teacher has more time to explain, since he does not have to write.
- It is cleaner (no rubbing of messy black-board again and again).

(iii) From students point of view

- They have more time to listen and understand the concepts, as they do not have to take notes.

Disadvantages

(i) From administrations point of view

- None

(ii) From teachers point of view

- There is more rigidity in the lecture as the contents are already documented. There is no spontaneity.

- Teachers own style is constrained. There is not much scope for innovation.
- There is no interaction. Mostly it is one-way traffic.
- Difficult to manage the class because of its size and the classroom environment.

(iii) From students point of view

- Lectures tend to go at a faster rate as compared to the traditional method. So student gets less time to assimilate the concepts.
- The charm of seeing the contents being developed is lost. In the traditional method, there is a sense of contents being developed then and there.
- The availability of notes, even if concise, gives student a false sense of security. They tend to be less attentive.
- The good students do not get an opportunity to interact with the teacher.
- The classroom environment makes them feel sleepy.

The positive outcome of this experiment was that some teachers have started using overhead projections partially to supplement their traditional classroom teaching.

Experiment 2: Workshops in Mathematics

In 1993, the mathematics faculty at IITB felt that efforts should be made to attract good students for the M.Sc. programs. I proposed to the department the concept of Workshop in Mathematics. Since 1994, it has become a yearly activity at the department. The Department of Science and Technology, Government of India funded the last four workshops.

Objectives

“Experience shows that it is unwise to expect much mathematical background in the case of a student entering college. Many dread Mathematics. They should be assured that mathematics is not so difficult, and it will prove interesting if carefully studied.

American Mathematical Monthly, 40 (1993)

“Do not satisfy your vanity by teaching great things. Awake their curiosity. It is enough to open their minds, do no overload them. Put there just a spark. If there is some inflammable stuff, it will catch fire.”

Anatole France.

The broad objectives of the workshop are to encourage final year graduate (BA/BSc) students for higher studies in mathematics. And this can be best achieved as follows:

- Workshop should be held in an examination free environment.
- Topics for the workshop should neither be too hard nor be disjoint from their course curriculum.
- Lectures should analyze not only what is in the topic, but also try to answer whys and how's of the topic.
- Efforts should be made to instill confidence for problem solving and to encourage independent thinking.

Methodology of the Workshop

Posters, announcing the workshop and inviting applications are sent to colleges in Mumbai, Pune, Ratnagiri, Kolhapur, Nasik, Dhule, and some other nearby cities. On personal level also

teachers are contacted and asked to recommend 2/3 students. On the average about 120 applications are received. Based on the marks obtained by the student and the teacher's recommendation, 40 students are selected for the workshop.

The topics of the workshop are selected keeping in mind the course curriculum of the students. Efforts are made to make the lectures inter-active and discussion oriented. Students are encouraged to discover and develop independent thinking via problem sessions. Expository lectures are arranged to give an over-all view of some topics. A carrier-guidance-lecture on the avenues for higher studies in mathematics at IIT Bombay is also organized. Lecture notes are prepared for the topics to be taught and are distributed to the students.

Students' feedback on the 6th workshop conducted in the year 2000

At the end of each workshop, the students are asked to give their feedback in a form. A summary of the feedback received for the workshop conducted in the year 2000 is as follows:

(1) How did you find the lecture contents of the topics?

Topic →	Set Theory	Probability Theory	Linear Algebra	Analysis
Nature ↓				
Heavy	28%	5%	19%	45%
Medium	8%	45%	47%	25%
Light	8%	---	5%	3%
Totally New	--	--	--	2%
Not new but useful	56%	50%	29%	25%

(2) How useful were the problem sessions?

Do you think more time should be devoted to them?

Very useful	Useful	No Response	More time
64%	25%	11%	80%

(3) How were the non-academic facilities?

Very good	Good	OK	No Response
61%	20%	2%	17%

(4a) Do you think such workshops are useful? Yes -**100%**.

(4b) Do you think such workshop should be held in the future also? Yes - **100%**.

OUT OF THE PARTICIPANTS EACH YEAR ABOUT EIGHT TO TEN PARTICIPANTS GET SELECTED AND JOIN M.Sc. PROGRAMMES AT DEPARTMENT OF MATHEMATICS, IIT BOMBAY.

Before drawing any conclusions from the above experiment, I would like to present to you another similar experiment.

Experiment 3: Mathematics Training & Talent Search Program (MTTS)

Introduction

During the “Discussion Meeting on Harmonic Analysis” held at Indian Institute of Science, Bangalore (India) in 1992, a session was devoted to discuss the academic preparation of the students who come for Ph.D. programs in Mathematics in various Universities and Institutions in the country. In order to improve the level of Ph.D. aspirants it was felt that a training program should be started (starting at the B.Sc. level itself) which should expose bright young minds to the excitement of doing mathematics. The National Board for Higher Mathematics (NBHM) of India was approached with the proposal and it agreed to fund the program. The first program was held in the summer of 1993. This program is being conducted every summer since 1993 under the directorship of Prof. S. Kumaresan, Department of Mathematics, University of Mumbai, India and funded by NBHM.

Methodology:

The program consists of 3 levels: 2 for undergraduate students and one for postgraduate students. The program is advertised in leading national newspapers and applications are invited for participation. On the average about 1500 applications are received out of which about 120 (140 for each level) participants are chosen. The daily program consists of 3 hours of lectures in the morning, 2 hours of problems sessions in the evening on basic topics: Algebra, Analysis, Geometry, Topology, Number Theory, Probability Theory. Contact hours for each topic during the program (of 4 weeks) is approximately equal to that of a one-semester course. Some teachers are also invited to the workshop.

Objectives:

- To teach mathematics in an interactive way rather than the usual passive presentation. To promote active learning, the teachers usually ask questions and try to develop the theory based on the answers and typical examples. At every level, the participants are encouraged to explore, guess and formulate definitions and results.
- To promote independent thinking in mathematics.
- To provide a platform for the talented students so that they can interact with their peers and experts in the field. This serves two purposes: (i) the participants come to know where they stand academically and what they have to do to bring out their full potential and (ii) they establish a rapport with other participants and teachers which help them shape their career in mathematics.
- The precise and linear exposition of a typical textbook often leads students to believe that mathematics is a dry, rigid and unchanging subject. The program aims at dispelling such beliefs and tries to exhibit to them the vibrant nature and the essential unity of mathematics.

The program is highly appreciated by the participants and teachers. Many of the participants have gone for higher studies and write back appreciating the training they had received. Some are now teachers at colleges and feel that the training at MTTS is enabling them to do a better justice to their jobs.

Conclusions

As is clear from the advantages and disadvantages listed in the first experiment, neither the teachers nor the students found the experiment worth continuing. Both found it too monotonous and devoid of any human interaction. The success of the second and third experiment lies mainly in the facts that in both these programs there is lot of interaction not only between the teacher and the students also between the students themselves. The interaction not only helps students to understand the subject better, it is also useful for the teachers. It helps them to know the stumbling blocks in the process of understanding of the students and to devise new ways/methods of presenting the subject. Students are not under pressure to perform (for an examination) or to compete with each other. They get a chance to ally their simplest doubts. They find there is spontaneity, concepts being developed in front of their eyes rather than just being displayed. Teacher also feels happy when he sees a glint of satisfaction in the eyes of the students. For him there is a sense of achievement. All this is because there is active (interactive) teaching. There is a human touch and that makes all the difference. I feel, whatever technology we bring into our teaching, it should only be to assist the teacher to make the human touch more effective and not replace it.

REFERENCES

- [1] Ghorpade, S.R. (2000) Teaching calculus-using internet: Some experiments and experiences. Proceedings of International Conference on Science, Technology and Mathematics Education for Human Development (Goa, India).
- [2] Ghorpade, S.R. & Limaye, B.V. (1998): A First course in calculus and Analysis (In preparation, for more details see: <http://www.math.iitb.ac.in/~srg>)
- [3] Website of the workshop in Mathematics: <http://www.iitb.ac.in/news/work/>
- [4] Website of MTTs: <http://math.mu.ac.in/mtts/>