The futility of teaching mathematics to engineering students, in an Indian University

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Abstract : This paper looks at a fundamental issue concerning the creation of world class engineers. It is an introspection into the pathetic state of teaching mathematics in Indian schools of engineering. Some of the causes are analysed and a few suggestions have been made.

1. PREAMBLE

This article is necessarily provocative and hence controversial. It exposes certain weaknesses in our approach to teaching mathematics (to students of engineering, in particular). It is however not meant to offend or humiliate any person, any persons, any institution or any organisation. The author makes a honest and undiplomatic effort to seek the attention and support of people or organisations who can help to improve the situation. The observations made here, are mostly subjective and opinionated. The reader is invited to appreciate this article considering the spirit in which it is written.

It is very well known and accepted that proficiency in mathematics is a fundamental necessity for any successful engineer. Bad planning, unrealistic goals, and penury of resources make teaching this subject all the more hazardous. What is needed, is a more realistic and effective approach to teaching of mathematics, considering its importance in making truly powerful engineers.

On a global scale, the overall quality of our engineers may be termed as just above average or mediocre (except the achievements of very few individuals).. This is largely due to the lack of profoundness in their mathematical background. They are mostly victims of a system where maths teaching gets nothing more than lip service.

These may appear to be very unfair comments, but they come from long years of experience and exposure to the system in India [1] and are also influenced by this. author's frequent visits and interactions with many reputed institutions abroad.

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2. A QUESTION OF ATTITUDE

In an engineering college, where students look for exciting "engineering" experiences, acquiring mathematical skills is instinctively pushed to the background. The zeal to excel in hard-core engineering subjects (e.g. machine design) leads to a view that maths is an unnecessary evil. Nothing tangible has been done or is being done, to remove this mental blockade.

To make matters worse, mathematics is taught by teachers (albeit highly competent) from the "humanities" department, where they are considered "outsiders" by their engineer colleagues. Conversely, pure mathematicians feel that their engineer colleagues who teach maths are generally "polluting" and vulgarising mathematics. An invisible divide is created in the institution, which also gets percolated to the attitude of students vis a vis mathematics.

And finally, the planners seem to think that imposing a very ambitious and rich syllabus is enough to transform the students into maths wizards.

3. A QUESTION OF RESOURCES

When was the last time we heard about an Indian, working in India, winning the Nevanlinna Prize or the Fields Medal ? (How many of us, maths teachers and maths students, have ever heard of these prizes ?) In a country which boasts itself as a superpower in Information Technology how many of us are worthy of a nomination for a Turing Award ? Will we ever achieve any of these awards ? Are we preparing our students to work for these awards ? Are we giving them the right resources ?

The Internet and the world-wide-web offer an excellent and alternate means for acquiring knowledge. Either our colleges are not at all equipped to give this facility to all their students, or the students have no time to explore this gold mine of knowledge. We have not done much to encourage this non-conventional mode of learning. Even many teachers have no access to the w-w-web. In fact, this author is appalled and disappointed at the number of his Indian colleagues who have e-mail addresses like : yahoo.com, rediffmail.com, hotmail.com. Even teachers do not see it necessary to subscribe to a good, commercial ISP. If this is the case of teachers, the case of education institutions is much more pathetic and shameful. Even rich institutions do not feel guilty or ashamed of using "hotmail.com" or "yahoo.com" as their official mail addresses. They flaunt these, even on their official stationery. Under such conditions, how can we ever dream of creating good engineers at all ?

The author recently undertook an informal survey of the availability of maths journals and magazines in some engineering colleges. As expected, the results were pathetic. Many institutions have never even heard of SIAM or Samasya or ACM . The author saw rows and rows of obscure trade magazines (with lots of advertisements) on the library stacks where journals were to be on display. Our colleges do not even know the difference between an academic/research oriented journal and commerce/business oriented magazines. What a pity ! This ignorance shows up directly in the quality of our students.

Many colleges surveyed by this author, have no access to mathematical packages like : Mathematica, Maple, Matlab, Scilab. In fact most of the teachers of these colleges are themselves not aware of these products. How can we expect our students to be wizards, when we deny them even these fundamental resources. Our policy makers and course designers seem to be unaware of these resources and their importance.

4. A QUESTION OF SETTING REALISTIC GOALS

There are many visible signs of attempts to make the engineering students more proficient and confident in mathematics. Like all well-intentioned attempts even these tend to be counter productive if overdone. An overdose of medicine is just as fatal as a lack of medicine. The syllabus imposed by parent universities tends to take the best of maths syllabus from universities overseas and make a huge concoction of all the ideas. The concoction is expected to be delivered to the student in a ridiculously short period of time. The student ends up getting a total aversion to maths or gets a

confused and jumbled up knowledge of the principles of this beautiful subject. So overwhelmed is he (or she) by the syllabus to be covered that he cannot see the true intent of those who designed such an ambitious syllabus. “As he was ambitious, I slew him” said Brutus, after killing Julius Caesar. The student kills all his interest and love for mathematics, due to this unrealistic and ambitious overdose.

Here is an example (although questionable) of this phenomenon: The author is a full-time Professor of Computer Science in an engineering college. He has been given the challenging task of teaching “discrete mathematics” to young students who are in their third semester of an 8 semester course. The syllabus imposed is amazingly thorough and complete. But, the teacher is given exactly one semester to cover this rich syllabus.

A word is in order about the subject -- discrete mathematics. This is a vast subject with no specific bounds. It consists of thousands of new concepts and ideas which are not related or bounded by a common thread. Each concept is to be defined first, ab-initio, before giving its properties or uses. The definitions itself may lead to the use of other concepts which need further definition. Lack of a common thread leads to a bewildering variety of standalone problems. By contrast, a subject like “differential calculus” takes a steady and progressive flow, from simple concepts like finite differences, to differentials, to more advanced concepts like partial differentiation and higher order differentiation, and then leads to applications like maxima and minima etc. The student gets a feeling of growing with the subject. This is not the case with “discrete mathematics”. Yet, the university treats these two with the same kind of “one-size fits all” approach.

A total of three books have been prescribed (for discrete mathematics), by the university (where this author teaches) [2][3][4] : The choice of these books is itself questionable. The teacher is expected to cover the material in all these books, since the parent University retains the right to frame questions from material contained in any of these books.

M+T	606 pages
M+B	751 pages
K+R	524 pages

	1881 pages

This adds up to about 1881 pages of very heavy and profound mathematics. At the same time, let us take a look at the duration available to cover this syllabus. The duration of one semester may be taken to cover about four months (about 16 weeks), at the prescribed rate of 4 lectures per week, this works out to 64 lectures. Considering imponderables and unplanned holidays etc. , it is reasonable to expect just 60 lectures for delivering the above material. A short calculation would show that the teacher will have to cover the equivalent of 32 pages in each lecture (average duration 50 minutes each). Even if we read out each page, verbatim, like a TV news reader, we will need more than an hour to read out the above. The author admits that the above example is exaggerated, and that there is a simple fallacy in the above computation -- the books mentioned above, are not disjoint in content, and have a lot of overlap between each other. The total independent material to be covered (intersection of the contents of all these books) may be much lesser in volume. However, the above count is still a fairly good way to estimate the volume of material to be covered , because we have to give allowance for the time spent on working out demonstrations and examples, presenting related ideas and also covering material from other sources and books. We will also have to give allowance for interaction with the students (classroom questions and answers) and possible repetition of material which may not be clear. There is clearly not enough time to cover the subject in its entirety and profoundly, as one would like to do.

Having seen, from a teacher’s point of view, the futility of teaching such an ambitious syllabus, let us take a look at the this from the learner’s point of view. Often, the student lacks a profound understanding of the basic topics which would be essential for following such a course. It is interesting to note that the University concerned makes no mention of the prerequisites for following

such an important course. Neither is there any scientific assessment of the cultural and linguistic background of the students. This is a major lacuna in the current system.

The course being taught (discrete mathematics) is an abstract subject. It is full of definitions and terminology, and weird symbolisms It takes time to absorb all the ideas and concepts taught in the classroom. In maths, the learning curve is usually flat, and not as steep as in the case of more concrete subjects (e.g. programming). The student hardly gets any time to introspect and consolidate. He is already dumped with the next dose of maths before he can gulp what he has got in the last class. In addition to this torture, the student still has to catch up with all the other subjects he is being taught. They have no time, to do some supplementary reading.

This is a sure way to promote cramming as the only technique to succeed (in the exams). Students grow up to become just jugglers of formulae without any understanding of their importance. They get no time or opportunity to apply their minds and explore mathematics more profoundly. The students get no time to appreciate the beauty of the ideas that they have just been taught, much less, apply these to real life problems and situations.

5. A QUESTION OF COMMON SENSE

The planners seem to have forgotten completely an amazingly simple but effective tool for improving teaching (of mathematics). Surprisingly, they have given no scope for evaluation and criticism of delivery using peer review and evaluation by peers.

If we work out a simple and non-intrusive mechanism of evaluation, we can make teaching and learning of maths much more enjoyable. Peers and colleagues may be invited to regularly review and criticise (constructively), maths classes. Thus the teacher will get to know his weak points and will know how his teaching can be made more effective. The review should be done regularly and continuously during the semester. This does not involve any major expenditure (except the time of colleagues), and if done in the right spirit, it can bring in enormous improvement in our educational system. Such a mechanism should be institutionalised and not left to the goodwill and initiative of a few individuals.

To add injury to insult, some colleges follow a half-hearted, “feedback” mechanism using the students for giving the feedback. At the end of the year (or semester), each student is asked to fill up a hastily prepared, amateurish “feedback” form on the subject taught. This approach is dangerous and faulty. First, students lack the maturity and wisdom to appreciate the subject (maths). Two, they cannot envision the efforts of the teacher. Then, this feedback is taken at the fag end of the course, by which time it is too late to make any corrections. Finally, students do put in their own personal prejudices into such feedback. The feedback mechanism makes no allowance for the cultural background or linguistic skills of the student. The student may not have understood the topic just because of a lacuna in his linguistic powers, and not because of the technical complexity of the subject or the lack of competence of the teacher.

6. A QUESTION OF FINDING THE RIGHT ANSWERS

Maybe we should take a good look once again at our approach to teaching maths, if we are serious about generating world class engineers. Maybe we should make our syllabus more realistic and more focused and compact. Maybe we should make available more technology resources (e.g. Internet and w-w-web) for self learning and exploration. Maybe maths teaching should be seen in the complete context of higher education in India, taking into account how effective we have been till now, in this matter.

These are fairly complex issues to be solved. There is no easy solution. For the sake of our society and for the sake of our country, we have to take this challenge more seriously and handle it with more maturity and wisdom. Meanwhile, as we fumble for answers, hundreds of thousands of children are being led into a world of confusion and mediocrity. Let us all introspect and find out solutions, without messing up this scenario any further. This author is willing to offer all his services

and time for this important social cause. If we really want the quality of our engineers to be really world class, we must find an effective solution to the problems invoked in this paper.

The author has a long experience in studying the enigma of teaching mathematics [1]. He is currently a Professor in an engineering college (in a typical Indian, rural setting). The views expressed here, are purely his own, and do not reflect those of his employers. In view of its controversial content, the name of the institution where this author teaches discrete mathematics, is withheld.

The paper is obviously biased and restricted in scope. Yet, it highlights a certain weakness in our approach to teaching higher mathematics.

7. ACKNOWLEDGEMENTS

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8. REFERENCES

1. S. Parthasarathy , Why is it so difficult to teach (mathematics) ? Mathematical Education, Vol. 9, No. 4, June 1993.

2. J P Tremblay, R Manohar , Discrete Mathematical Structures with Applications to Computer Science, Pub.: Mc GrawHill Book Co., Singapore

3. J L Mott, A Kandel, T P Baker, Discrete mathematics for computer scientists and engineers, Pub.:Prentice Hall India.

4. Kolman, Busby, Ross, Discrete mathematical structures, Pub.: Pearsons education.

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