Distance Education Through Technology Mediated Learning : The Engineering Education Scenario In India

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ABSTRACT

The paper addresses the ways in which India is trying to improve the quality of engineering education in the country and provide wide access to such education through technology mediated learning. Appropriate training of teachers is the other area of focus that will help achieve this goal and lead to a virtual university in future.

INTRODUCTION

Rapid industrialization and globalization has opened up the world, with new possibilities and career options emerging in various fields of engineering and information technology. In India, the impact of such globalization has resulted in a sudden rise in the demand for high quality engineering education. It is one of the major priorities in the field of education in India now, to make such programmes available to all.

There are two major stumbling blocks towards fulfilling this demand. A brick and mortar solution to the problem is often not practicable due to lack of funds, space, infrastructure and absence of capable teachers. There is a great dearth of sufficient engineering colleges, and even existing institutions suffer from a lack of good teachers and infrastructure. However, rapid improvement in information technology has recently resulted in the availability of a wide range of IT tools, which can be used both for production of high-quality educational material, as well as extensive and effective dissemination of such material to all who seek quality education. This means instructional material produced by good teachers - in the form of video-based lectures, e-learning material, to be accessed by a large number of students irrespective of geographical boundaries. It would thus extend

the outreach of quality education considerably – without phenomenal increase in cost. Technology mediated learning would therefore seem to be the most obvious solution to this problem.

The other aspect of dealing with this challenge lies in improving the capabilities and qualifications of existing teachers in more than 1,300 engineering colleges across India. Unlike at school level, in engineering education there is no formal training system available to prepare newly appointed teachers for their job. As a result, even face to face teaching varies widely amongst institutions and is often far from satisfactory in many of the institutions. Well-organized training of such teachers would not only improve the quality of education in their respective institutions, but also create a large body of personnel who could contribute effectively towards the production of high quality instructional material, and act as facilitators in future e-learning or blended learning mode.

A judicious combination of the two approaches could result in considerable improvement of both the quality of engineering education and of extending its outreach and usher in a new era of high quality and effective distributed learning.

TECHNOLOGY MEDIATED LEARNING

Nationally Co-ordinated Project on Educational Technology

India has already taken steps to utilize the vast potential of technology to increase educational outreach. The Government has initiated several programmes to promote "technology mediated learning", to overcome the problem of providing quality education in the various engineering colleges in the country (Bhattacharya 2003a).

The "Nationally Co-ordinated Programme in Educational Technology" was the first such attempt to create video-based course materials in different areas of engineering education. The programme concentrated on building up an infrastructure for course production in some of the premier institutes of the country and then on using them to develop these courses. Some of the institutions that participated in the project have produced a considerable number of such courses. IIT Kharagpur is one of the 7 Government – appointed "institutes of excellence" in engineering education in the country. In independent surveys by media agencies, the institution has been rated as the "first" amongst all the 7 IITs

in the country for three consecutive years. IIT Kharagpur alone has produced more than 60 full-semester UG / PG courses – which are some of the best regular courses of the institute. These are recorded live in a specially equipped studio-cum-classroom through on-line editing. Each course consists of around 40 one-hour lectures. The teacher is required to sit at a table and do his "board work" on a blue-tinted paper with thick coloured pens. There is a camera positioned right above this paper that picks up the teacher's "board work". Another camera is placed in the front of the teacher to record the teacher's face when he is speaking / explaining. A third source of input is the PC, which the teacher may use to demonstrate slides / programmes, etc. On-line editing takes place through a switcher which is used to record the relevant camera / PC source at the proper time. Since lectures are recorded in the on-line editing mode, each lecture is ready for copying and dissemination, as soon as the class is over.

The courses are converted to CDs and sold at a nominal (non-profit) price to other institutions. In institutions that have a LAN framework, these courses are often loaded onto an internal server and used in the "video-on-demand (VOD) mode". In both the use of CDs as well as in the VOD mode, control of learning pace remains with the learner, (ie., the learner is able to "stop / start / pause / rewind" any portion of the course). In previous studies using video courses, where the control remains with the learner, learning gain has been found to be very high (Stone, 1987). Many engineering colleges do not have adequate faculty in various disciplines. Consequently these courses are often used to alleviate teacher shortages in such institutions and are in great demand amongst both students and teachers as learning material. Use of these course materials in CDs or VOD mode have also been found to be specially beneficial to students having a "language" problem, or other learning disadvantages (Gibbons 1986). Apart from educational institutions, the courses are also procured by R & D organizations and industry as training material for their staff. Even when sold at a nominal (non-profit) price, they have yielded a sale proceeds figure of more than $2,30000/-.

OFF-CAMPUS DISTANCE EDUCATION PROGRAMME THROUGH COLLABORATIVE GROUP LEARNING (CGL)

The enormous response to the video-based courses produced under the NCP programme triggered the possibility of using video-based instruction to fulfil the extensive demand for training in IT related areas. An innovative off-campus distance education programme was launched by the Centre for Educational

Technology at IIT Kharagpur to provide certificate courses in IT-related areas across the entire country. This programme – called the **El**ectronically **Net**worked **L**ife **L**ong **L**earning **(ElNet-3L)** programme was not just a response to the rising demands for access to Continuing Education for knowledge updation, but was also an experiment to test several important academic and implementation issues closely related to any large scale Off-campus Distance Education Programme (Bhattacharya and Ray, 1998). The aim here was to design a model for a distance education programme that was :

a) Based on the time-tested academic model of "Collaborative Group Learning"
b) Financially self-sustaining
c) Extendable over a large geographical area while maintaining high academic standards

The Academic model

The academic model of the programme is based on a structure where learning takes place through Collaborative Group Learning in specially appointed Study Centres - through "Tutored Video Instruction" (TVI) mode. This is complimented by support material in the form of quiz, tutorials and lecture notes in print format. Six to eight students watch a video lecture for 10 min at a stretch and then break off for a 5 min discussion within the group for clarification of doubtful points. Studies in Stanford have already shown that learning through such "Collaborative Group Learning" methods resulted in greater learning gain for students than when they learnt through regular classroom lectures (Gibbons 1986).

In this mode of instruction, a local tutor would be present, but instead of actively answering questions, he / she encourages the group to clarify their own problems through discussions. Similar models used during satellite broadcast of courses offered by the National Technological University, USA, as well as in a controlled study in IIT Delhi in India has shown high effectiveness of student learning (Stone, 1987); and in CAI package-based learning (Schlecter 1990; Mevarech et al 1991; Kendl & Liberman 1989; Howe et al 1991; Eraut & Hoyles 1989; Kapoor 1996).

In the ElNet programme, in instances where doubts could not be resolved by discussion within the group, queries were sent through email to the course faculty and were answered through email too. Over a period of time, the queries and their answers were put in a FAQ file within a group website – to help the learners. Examinations were held under strict surveillance in several examination centers

across the country and students awarded a certificate with their "grade" of performance when they were successful in the examinations.

The Implementation model

To ensure proper implementation of the course, financial sustainability and a wide outreach, a three-tier model was adopted, where the academic expertise was provided by IIT Kharagpur, the administrative responsibility lay with a private enterprise (called DACP (P) Ltd., and the actual setting - up of the centres was carried out by individual private franchisees. IIT Kharagpur entered into a contract with DACP (P) Ltd, who thereafter looked after the organizational aspect of the course and ensured that the study centres were run according to the norms specified by IIT Kharagpur.

Since setting up of such elaborate Study Centres requires major financial input, to the tune of $35,000 dollars for each centre, DACP (P) Ltd invited individual franchisees to open these centres in different parts of the country, through which the courses were then disseminated. Small groups of students followed the videotaped lectures in the Collaborative Group Learning format. Laboratories were also provided in the centres with necessary hardware and software requirements. The Study Centres had email connections so that the students could contact the faculty at IIT Kharagpur for solution of problems encountered during viewing of the courses.

Within a span of five years, from 1997 to 2002, more than 12,000 students went through these courses in 110 study centres in India and Bangladesh. The programme was immensely successful and feedback collected from students showed a very high level of satisfaction with the programme, as well as with the mode of learning (Bhattacharya, 2000).

OTHER DISTANCE EDUCATION PROGRAMMES IN ENGINEERING EDUCATION

Post Graduate Diplomas in IT and Management

The success of the ElNet programme prompted IIT Kharagpur to start offering postgraduate diplomas in Information Technology and in Management through "mixed mode" in its two extension campuses in Calcutta and Bhubaneswar. As in

the previous model, this mode also consists of Tutored Video Instruction, where courses are developed, recorded, transcribed to CDs and given to students for learning through group viewing and discussion. However, the video lectures are also supplemented by face to face interaction with teachers every weekend. This mode of learning is working well with the added benefit of the face-to-face interactions between students and teachers. However, this face-to-face teaching element itself acts as a deterrent for the model to be extended to cover a wide geographical location. As a distance education programme, therefore, it is not "scalable" and educationally productive.

National Programme on Technology Enhanced Learning (NPTEL)

The aim today, however, is to make "quality engineering education available on demand". It is with this aim in mind that the Ministry of Human Resources & Development (MHRD) has initiated a "National Programme on Technology Enhanced Learning" (NPTEL) which is aimed at developing an organized and well-structured plan for the creation and dissemination of high quality instructional material in different formats of e_learning – including video based, CD ROM-based and web-based courses. These courses will then be disseminated to all engineering colleges in the country – free of cost. It is expected that this would remove the wide disparity in educational standards in different engineering colleges, and help improve the quality of engineering education in the country.

The primary aim of the programme is to use Technology Assisted Learning (TAL) to supplement and not to replace classroom teaching. The design and preparation of course material, therefore, needs to keep in mind the fact that it should facilitate and bring "quality in teaching" to all.
The main objectives of the programme are :

a) Producing video courses, web-enabled courses for UG level engineering education.
b) Using these instructional material to supplement and enhance classroom teaching across institutions
c) Increasing student-staff ratio.
d) Overcoming faculty shortage
e) Using internet multicast / unicast technology for dissemination.
f) Setting up a VIRTUAL UNIVERSITY, in due course.

This programme is a joint initiative of seven premier engineering institutes of the "Indian Institute of Technology" (IITs) and the Indian Institute of Science (IISc).

These institutions have been assigned the role of "Partner Institutions" under the programme. In the initial phase, they are responsible for the development of the required instructional material. Other centrally funded institutions like ISM Dhanbad, National Institutes of Technology (NITs), etc. have been accorded the role of "Associate Partner Institutions". They will act as the "user institutions" and in later phases of the project could also act as "content providers".

An initial target has been set for developing 100 digital video-based courses and 115 web-based courses. Both video-based courses and web-based courses have their own advantages. Video courses give an impression of "eye-contact" with the lecturer. They also provide all verbal and non-verbal messages and communication from the teacher and are perceived by students to resemble a live lecture to a certain extent. However, video courses are not interactive. They offer a one-way flow of information from the teacher. To bring in interactivity, it was decided that "administered web-based courses" would be most appropriate. Such courses would be modular in nature and include formative and summative evaluation while offering scope of be administered within an institute by the teachers of that institute. This would allow more interaction between student and teacher through "tutorials" within the institute LAN.

The video courses would be telecast through a dedicated "Technology Channel". Facilities would be provided to all engineering colleges to download these courses for viewing. Web-based courses could be also used as CD-ROM – based courses where there is no internet access. Core science courses offered in the first year of engineering programs, which are mainstream engineering programs, namely undergraduate Degree Programs in Civil, Electrical, Mechanical, Chemical, Electronics & Communication and Computer Science Engineering, have been taken up initially. To ensure that the syllabi of these courses are not too different from those in the user institutions across the country, the common curriculum for all engineering colleges already approved by "All India Council of Technical Education" (AICTE) is being followed. As far as possible, full programs in each discipline have been covered.

The web-enabled courses are being produced in a modular structure, with each module including learner interactivity and formative assessment to help better learning. The aim is to bring in an interactive learning atmosphere in a class. However, at present, a vast number of engineering colleges in India do not have internet facilities. The courses are therefore being designed in such a manner that even though they would be web-enabled, they can also be used as CD ROM-based courses in the absence of internet facilities.

Outreach Programme

Even before the NPTEL programme is completed, there have been consistent demands from the industry for courses in emerging areas which could lead to enhancement of qualifications for the staff. In response to this need, the Government of India has now conceived of a programme called the "Outreach Programme". This programme is concerned with developing courses in video, web and CD Roms for the updating of knowledge on the part of people already working in the industry. The programme seeks to offer a "credit-based education system" where credits can be accumulated to lead to certificates / diplomas or degrees. The focal points of the programme are :

a) Flexible approach to blend Natural Science, Engineering Science, Information Technology and Management courses.
b) Credit passbook system which will be updated continuously.
c) Specific locations of Outreach Education Programme (OEP) centers in the country.
d) Flexible delivery technology via video and web-based instructions.
e) Flexible exit option (degree/diploma/certificate).
f) The programme will be financially self-sufficient.
g) The programme is now in the planning stage where details are still being worked out.

INCREASING LEARNING EFFECTIVENESS THROUGH IMPROVEMENT OF TEACHER CAPABILITIES : THE QIP PROGRAMME

Technology provides us with facilities for wide dissemination of instructional material. However, mere dissemination of information does not lead to learning. It is the main role of the teacher to ensure proper design and integration of relevant information into courses for specific groups of learners that result in assimilation and understanding on the part of the student. Only when the student is able to succeed in formative and summative evaluation tests devised according to the specific instructional objectives of the courses, can actual "learning" be deemed to have taken place.

In his second role, the teacher would be required to act more as a catalyst in providing inspiration, guidance and learner support to every learner in a course. In the new era, the teacher needs to move from an "instructionist" to a "constructionist" role within the teaching-learning process. He has to become more of a guide, mentor and facilitator. The role of the teacher today therefore is no longer restricted to propagation of information. His role is evolving in these two distinct dimensions.

As mentioned earlier, however, there is a fundamental problem in both the number of teachers available in engineering educational institutions in the country, as well as the lack of training of such teachers – leading to a less effective teaching-learning outcome than would be desirable.

One of the steps taken by the Government of India to improve the quality of teachers in engineering institutions has been through the "Quality Improvement Programme" (QIP).

In this programme, some of the major institutions in engineering education - which have facilities for post-graduate education – have been identified as the nodal centres and are entrusted with the responsibility of imparting training to teachers of other engineering colleges. Teachers from Government sponsored engineering colleges are sent to these nodal institutions to gain higher degrees in their respective fields. Study leave is accorded to such teachers to enable them to further their knowledge and research capabilities and gain higher qualifications. They also profit from exposure to effective teaching methodologies through interaction with the teachers in these nodal institutes.

This "improvement in quality" was mainly sought to be achieved through systematic retraining of teachers of the engineering colleges, in the following ways:

a) A three-year sponsorship for faculty (from the parent institute) to any of the QIP centres for research work leading to a Ph.D. degree.

b) A one-and-a-half year sponsorship for faculty (from the parent institute) to any of the QIP centres to study for an M.Tech. degree.

c) Organising QIP short-term courses and workshops in different emerging areas for the benefit of the teachers from these institutions.

A study of the usefulness of this programme, however, has brought to light both the positive and negative aspects of the programme (Bhattacharya 2003b). Feedback from teachers who had undergone the programme showed that they often did not consider the programme to be helpful to them in incorporating new teaching methodologies, adopting better evaluation techniques, or providing them with insight for updating of courses in their parent institutions.

Therefore, to be really useful, the programme needs to be modified greatly. One of the problems may have been the fact that the concept of "Quality" had never been clearly defined. A national review of the QIP programme conducted in 1992 states that "Improvement of Quality" includes improvement in the quality of teaching and research, and undertaking of consultancy and projects. The review goes on to state : "It is often assumed that since the QIP scholars are all teachers in various engineering colleges, they would be automatically motivated towards improving their teaching / research skills and orientation through the programme." (MHRD 1992). It is therefore left to the individual teacher to interpret the implications of "Quality Improvement" and act according to his own understanding. A "Quality Improvement Programme" that includes a clearer focus and training on teaching methodology, evaluation methods, Socratic teaching methods and mentoring would possibly serve the purpose of improving "teacher quality" to a much larger extent. It cannot continue to concentrate upon a means for the teacher to get a higher degree only. It needs to become an enabling factor for teachers and equip them with the means and abilities to help students to learn effectively. It is no longer even sufficient to enable teachers to "teach well". Future programmes have to bring about changes in the mindset of the teacher – to shift their orientation from "teaching" students to enabling students to "learn", to assimilate knowledge, to criticise, question and apply what they have learned.

CONCLUSION

India, like other countries, is aware that a new age is dawning – one that will be characterised by unimaginable advances in knowledge and synthesis of knowledge, triggering major changes in the objectives, contents, and methods of higher education. The high rate of obsolescence of knowledge will result in greater emphasis on lifelong education and the realization of a learning society. Various kinds and generations of technology will continue to evolve and serve as prime enabling factors in dissemination of instructional material as well as providing for interaction between students and teachers separated by geographical distance. But

to put this power to effective use, we need to develop well-structured plans, methods and capabilities for creating appropriate and high-quality instructional material. Teachers will have to be trained to play a major role - in enabling the students to think for themselves, in learning to learn. To equip teachers to deal with this state of affairs, QIP programmes will have a much larger role than before. A judicious combination of these two approaches could allow effective technical education to be extended to all and provide quality education for all students in all institutions. This would be a true beginning of the virtual university in the future.

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