National Programme on Technology Enhanced Learning (NPTEL): OER and Beyond

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Abstract

The National Programme on Technology Enhanced Learning is an Indian national initiative co-ordinated by the Indian Institute of Technology (IIT) Madras with partners from other IITs and the Indian Institute of Science, in Bangalore. The programme is funded by the Ministry of Human Resource Development, Government of India, and is geared towards providing detailed course content, free of charge, to academic institutions and individuals in all branches of engineering, science, technology, management and humanities subjects which form a part of higher education (i.e., beyond Grade 12). At the end of 2012, it is hoped that all major undergraduate and a number of post-graduate curricula of most engineering and technology programmes will be covered with the availability of 40-lecture (or equivalently, one semester long) course content for more than 1,000 courses. The programme will supplement this activity by providing hands-on training to young teachers on curricula and pedagogy. Efforts are also being made to answer users' queries, to provide supplementary materials, online quizzes and assignments, and to collect user feedback so as to update course content on a continuous basis. It is also proposed to set up a virtual technical institution for granting online certificates and degree/diploma programmes in the future.[1]

Keywords: India, NPTEL, IIT, higher education, professional education, distance education, continuous open learning

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[1] Dedicated to the memory of Professor Paul Goodman, Professor of Organizational Psychology, Tepper School of Business, and Director, Centre for Strategic Learning, who passed away on 24 January 2012 in Pittsburgh. Paul was in many ways more than a friend, philosopher and guide to the NPTEL team, and through his vast experience with technology enhanced learning, influenced the thought processes of several of us.

Introduction

The National Programme on Technology Enhanced Learning (NPTEL) is an initiative in which several Indian Institutes of Technology (IIT Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and the Indian Institute of Science (IISc, in Bangalore) are partners in creating complete, free and open courseware online for engineering, science and management subjects, and in training teachers in Indian technical institutions to help improve the overall quality of technical and professional education and the employability of Indian graduates. The contents are, however, available free to everyone in the world and follow closely the curriculum design adopted by major technical universities in India and abroad.

The NPTEL project originated from many deliberations between IITs, Indian Institutes of Management (IIMs) and Carnegie Mellon University (CMU, in Pittsburgh, Pennsylvania, USA) during the years 1999–2000. A team of directors from IITs and IIMs had visited several institutions in the USA in 1988 to study technology-enhanced learning (TEL) processes and possible roles for these in the Indian educational sector. This was followed by a joint workshop involving nine IITs and IIMs, industry partners from InfoSys, Tata Consultancy Services, Wipro and the National Institute of Information Technology, and members from the government sector, including the Secretary of the IT and Education Ministries. The workshop was held at IIT Madras in 1999 under the co-ordination of Professor Paul Goodman, Professor of Organizational Psychology at CMU, Professor R. Natarajan, Director of IIT Madras and Professor M. S. Ananth, Dean of Academic Courses at IIT Madras. The workshop was funded by CMU. Professor M. S. Ananth put forward a proposal to the Government of India's Ministry of Human Resource Development on behalf of the five IITs (Bombay, Delhi, Kanpur, Kharagpur and Madras) and the IISc, to create content for 100 courses as web-based supplements to be distributed through the Internet (NPTEL, 2000).

The courses would cover lessons that could be delivered in approximately 40 hours. Five engineering branches (Civil, Computer Science, Electrical, Electronics and Communication, and Mechanical) and the core science programmes that all engineering students are required to take in their undergraduate engineering programme in India were chosen initially. Content for the above courses was based on the model curriculum suggested by the All India Council for Technical Education and the syllabi of major affiliated universities in India. The objective was to provide free and open, high-quality, authenticated (i.e., peer reviewed) course content covering the curricula end-to-end at both undergraduate and post-graduate levels, and to create electronic resources that could be used subsequently for launching a virtual technical university (Goodman, 2011).

The basic objective of science and engineering education in India is to devise and guide reforms that will transform India into a strong and vibrant knowledge economy. In this context, the focus areas for the NPTEL project have been (i) higher education, (ii) professional education, (iii) distance education and (iv) continuous and open learning, roughly in that order of preference.

Due to rapid economic growth in the last two decades and the opportunities for private partners to offer educational services, India has witnessed an enormous increase in the number of new professional colleges, with a consequent paucity in highly trained faculty with higher degrees and teaching experience, and poorer quality in the vast majority of its professional graduates.

Student enrolment has increased by an order of magnitude, from 150,000 entrants in 2000 to 1.4 million in 2011. However, the IT service sector has swelled to absorb every "employable" graduate, resulting in fewer graduates pursuing higher education. This has led to an alarmingly sharp decline in the number of teachers as well. NPTEL was designed both to address students' needs for quality content and to train and improve the quality of teachers through nationally designed curricula and massive teacher-training programmes, with the help of premier technical institutions.

The guiding principles for the programme were considered to be: (i) modularisation in the design of course content, (ii) authentication through peer review mechanisms, (iii) freedom for faculty to experiment with different course pedagogies and, above all, (iv) a service-minded approach by the faculty of the IITs and the IISc, including an environment in which any user of the course programme could pose queries and receive the desired response. However, a concerted effort by leading competitive educational institutions in India was an organisational challenge; in addition, a unified approach to providing detailed curricula that would, in future, also enable thousands of new educational partners to excel in their own spheres of education by suitable adoption and adaptation of courseware and training was a challenge for the online course designers. These difficulties could not be wished away, and considerable effort has been made for quite some time to address, if not entirely solve, these challenges.

In 2003 the Ministry of Human Resource Development formally funded the programme for IITs to carry out content development for 200 courses in engineering. A sum of INR (Indian rupee) 205 million was approved for the period 2003–2007 (approximately USD 4 million), and INR 960 million (approximately USD 18 million) was sanctioned for the second and third phases, from 2007 to 2012 (NPTEL, 2012).

At the end of the current project period (2007–2012), the programme expects to provide detailed lecture-wise content of about 40 hours each for approximately 1,200 courses, covering most major engineering and technology disciplines as well as post-graduate programmes in basic sciences and management. They include post-graduate courses in the five major disciplines covered in the first phase at the undergraduate level. All of this will result in a very large number of open educational resources (OER) of high quality and different pedagogies.

However, as stated above, OER are one of NPTEL's several objectives, and unlike in other OER initiatives, training and support are parts of the fundamental design that pose challenges for future scaling (Iyoshi & Vijay Kumar, 2008). Nonetheless, an academic consortium or collaboration of this nature from a single national entity, funded wholly by the government for a sustained period, proposing to involve multiple partners in all aspects of design, development and delivery of course content online for free, is the first of its kind in the world.

The Process and Operational Details

India needs many more teachers for effective implementation of higher education in professional courses. To a large extent, this is true in all developing countries. Therefore, methods for training young and inexperienced teachers to enable them

to carry out their academic responsibilities effectively are a necessity. NPTEL is expected to fill the void in a number of ways, namely:

- NPTEL content can be used as core curriculum content for training purposes.

- In addition, a large number of students who are unable to attend scholarly institutions will have access to quality content through NPTEL.

- All those who are gainfully employed in industries and all other walks of life, and who require continuous training and updating of their knowledge, can benefit from well-developed and peer reviewed course content from the IITs and IISc.

- Lifelong learners have all the more reason to use NPTEL content because it will be threaded quite carefully into content at all levels and into all fields of higher technical education.

To influence these processes in a systematic and sustainable manner, two committees were set up, referred to as the National Programme Committee (NPC) and the Project Implementation Committee (PIC). The mandate for the NPC, headed by the Joint Secretary/Additional Secretary (a senior Indian Administrative Service official in the Ministry of Human Resource Development who was familiar with online educational paradigms), was defined as follows:

- Function as a grants-in-aid committee and release funds.

- Constitute and approve subject-level groups for harmonisation of curricula.

- Ensure quality and certification of courseware produced.

- Ensure inter-institutional and inter-ministry co-ordination of academic activities and with the All India Council for Technical Education.

The PIC — consisting largely of TEL co-ordinators of participating institutions to co-ordinate the project at the institute level, and chaired by Professor M. S. Ananth (Director, IIT Madras, 2001–2011) — was the main body to operationalise the programme at the participating institute level and had the following mandate:

- Prepare the detailed programme implementation plan.

- Allocate activities to different partner institutions and ensure inter-institutional co-ordination.

- Select and approve courses.

- Decide on standards conventions and notation, identify studio hardware/software infrastructure and ensure uniform quality of technical infrastructure.

- Devise strategies for updating courseware already developed.

- Plan and organise orientation and training programmes and workshops.

- Advise subject-matter experts on copyright and intellectual property rights issues.

- Ensure timely and effective implementation.

In addition, two national-level co-ordinators (the present author and Professor Kushal Sen, IIT Delhi) were nominated to co-ordinate the overall development of web-based and video-based course content. The PIC constituted subject-matter

expert groups early on for every discipline, and the members met several times and exchanged emails to arrive at a revised engineering curriculum by taking into account the model syllabi provided by the statutory body for technical education in India: the All India Council for Technical Education. They also examined the syllabi of three major universities with hundreds of affiliated engineering colleges (Anna University, Visvesvaraya Technological University and Jawaharlal Nehru Technological University) and fused their teaching experiences together with those institutions noted to write modular forms of curricula for a large number of courses.

Each module in a course would comprise two to five one-hour lectures, and between ten and 15 modules would comprise a course. About 60 to 80 per cent of this would have strong overlap with undergraduate curricula of most of the Indian universities, and the rest were intended to be optional. The subject-matter expert groups then sought faculty volunteers from all eight partner institutions, and duplication of the same course by multiple faculty was minimised by encouraging teams of two or more such members to develop the course together. In the first phase of NPTEL there were many such teams, often consisting of members from the same department of a partner institute, but there were also a number of teams with faculty from several institutes for the same course. The objective was to develop lecture content for all eight semesters in each and every discipline. The exercise took considerable time and effort, and there were many meetings and exchanges, as no two faculty members' teaching methods were alike. Through many discussions, a general consensus evolved on the details of course development in two formats: the Web and video.

The original NPTEL proposal did not have two formats, only web-based content development. The suggestion to create video-based lectures had been made in 2003 by Professor Murli Manohar Joshi, the then Minister for Human Resource Development. He requested the PIC consider recording lectures and broadcasting them over a television channel that would be created exclusively for that purpose.

Internet bandwidth in many academic institutions and many homes, particularly in rural India, was inadequate or non-existent, whereas television and telephones had major presences in every part of the country. With Ministry funding, the PIC helped standardise recording processes and set up broadcast-quality studios in all partner institutes. The PIC also assisted all partners in the creation of walk-in facilities, with the help of software and hardware infrastructure and technical manpower.

The Institute for Strategic Development, at Carnegie Mellon University (the brainchild of Professor Paul Goodman) was used as the model to create in-house facilities in all partner institutes, where faculty would be given adequate technical support to develop online content and to carry out experiments on TEL through new paradigms. The Web Studio created in IIT Madras is currently an institute- and nationwide facility, and is the co-ordinating and training laboratory for a number of similar programmes developed by other ministries.

The government promised a national satellite TV channel exclusively for broadcasting video lessons, 24/7 (and delivered it on Republic Day —January 26 — in 2004). The channel was named Eklavya, after the iconic distance education student of the great Indian epic, the Mahabharata. Eklavya was said to have practised archery in front of a mud statue of the best archer, Aachrya (guru,

teacher) Drona, whom he adopted as his teacher; this was because Eklavya, born to parents of a lower caste, would not be permitted to learn in the house of his guru along with the children of the king and the other elite members of society. As the story goes, he was asked later by Drona to give his thumb back as the Guru Dakshina so that he would not be able to beat the "on-campus" (Guru Kulam, the House of the Guru) learners of archery. Professor Ananth would promise in every subsequent meeting with students and teachers that this "history" would not be repeated in the present instance.

Current Status and Projections for the Future: Beyond OER

The story of NPTEL Phase I, with interviews from many of the programme co-ordinators, has been recounted coherently in an earlier publication (Walsh, 2011) that also sets the context of opening up education in many leading universities. The NPTEL website was formally launched on 5 September 2006 by the late Shri. Arjun Singh, Minister for Human Resource Development, and has been updated ever since with course content for more than 260 courses. The Web and videolecture content for about 1,000 courses in development under the current phase is being added incrementally. Several IT partners have come forward with offers to host the content on their websites. Google, through its video arm of YouTube, offered an educational channel to IIT in the same manner that it has provided channels to leading U.S. universities such as Stanford, MIT and Berkeley.

YouTube now has many commercial-free educational channels, and NPTEL's (at www.youtube.com/IIT) is one of the best-known academic sites, with more than 5,500 videolectures in streaming media (MPEG-4, H.264, 512 kbps bit rate) on technical subjects under about 130 playlists. The list grew substantially in 2012. Several million viewers have already visited, and tens of millions of visitors have benefited worldwide through hyperlinks to the channel on many other websites.

The official website of NPTEL (http://nptel.iitm.ac.in) hosts all the Web and video content organised according to subjects and also has updates on all activities of the project so far. In addition, the PIC has been meeting periodically and has enabled the present author (the national Web courses co-ordinator for this project) to carry out all its activities and be its spokesperson. The following are some of the activities being taken up:

- Conduct course-specific workshops by bringing together the faculty who developed the course and teachers who are likely to use the lecture material.

- Conduct workshops in selected regions all over the country so that a large body of students can also participate and learn the usage process.

- Create a subject index and keyword search for both video and Web materials so that students can use a search engine to find relevant materials across courses.

- Create course-specific bulletins and discussion boards on the website so that students can ask questions about the course material. Open learning will be supported by permitting answers by interested students and teachers, with occasional moderation of discussions by course developers.

- Create a course-specific Edupedia (similar to the powerful concept of Wikipedia) with the help of qualified teachers across the country, create a digital library relevant to course materials and make both resources available in the course area.

- Create course-specific FAQ through all of the above.

- Encourage teachers in various colleges to adapt the materials so as to prepare localised versions suitable for the examination system of their particular college.

- Share expertise on eLearning, content development and content dissemination with interested institutions so that they can set up their own eLearning portals.

- Distribute the NPTEL content — both Web and video — to any interested institution for its internal use.

- Set up a video-on-demand facility in IITs and the IISc, with sufficient exclusive Internet bandwidth for making videolectures available in the streaming format. This will help not only the students and teachers, but also industry professionals and open learners. Currently the NPTEL site at IIT Madras hosts the video server and needs to be mirrored in multiple locations as the courses and users increase.

- Create text transcripts of all videos to enable indexing of the videos and for future translation of the spoken content into many Indian languages. This will likely improve the learning prospects of a majority of Indian learners having difficulties with English.

This author had realised through conversations with students that often they were unable to distinguish between an inability to understand a concept and an inability to express the concept coherently in English; the student would, for instance, cite an inability to count in English faster than in his or her native language. English language teaching has also suffered a considerable setback in India in recent years, leading to other difficulties in higher education. For a country with more than two dozen official languages, providing educational aids equally in all the native languages is a significant and socially important step. Transcription of spoken text and translation of written text not only would help in addressing this problem, but would, in the long run, enrich Indian languages to build the necessary scientific vocabulary when this effort was taken further to develop courses in all spheres of higher education. It would also enrich the whole world with the reverse process of translation, from native learning and intelligence into English, since the tools for translation would also have been perfected through this effort.

The Mission Beyond

India is a vast country whose engineering student population outnumbers every other country's, with the possible exception of China's. The present objectives of NPTEL are: (i) to create content for science and engineering courses in all major disciplines as well as specialised and newly developing inter-disciplinary subjects for which there is very little academic expertise in private colleges, (ii) to help colleges through workshops and discussion boards for implementing

NPTEL content in their curriculum, (iii) to answer user queries with the help of subject-matter experts and collaborating faculty trained in the subject and (iv) to encourage teachers in other academic institutions to design additional support material.

Thus, NPTEL hopes to go beyond creation and free dissemination of peer reviewed OER by helping others who may need to train themselves in teaching and learning with the Internet. Also, course development is no longer restricted to IIT/IISc faculty, but is open to distinguished academics from all institutions who agree to the norms developed for creating courses, styles, mechanisms of peer review and periodic updating of content. Above all, a model curriculum for new institutions will continue to be built to facilitate threaded learning and make resources available to everyone in the world.

Currently, the distribution and copyright laws for usage are somewhat restrictive, but fair use for academic programmes is being encouraged. The system is moving towards more open copyright formats such as the "ShareAlike" and "Attribution" licence options of Creative Commons or their equivalents. Faculty members are being encouraged and supported both technically and financially to incorporate feedback from the user community in their courses and to revise their courses accordingly.

It is one of the fundamental goals of the project to bring in all the best teachers in the country under the umbrella of NPTEL, and either record their lectures or seek their collaboration with the IITs and the IISc to make their courses available for the community under free and open source licences and agreements. IIT Delhi has already initiated a move to create open virtual laboratories on the Internet for engineering subjects, which is extremely important for our country. Integrated with coursework provided by NPTEL, virtual lab demonstrations will significantly enhance the learning experience. Efforts are underway to link labs to the courses.

Another primary objective is to forge strong ties with major academic initiatives worldwide, such as MIT OCW, the Commonwealth of Learning, The Open University (UK), Open Universities Australia and Digital Library Initiatives (to mention a few), and with industry to develop new technological tools for learning and dissemination. The number of things that must be done simultaneously is enormous. As scholarly institutions of India, the IITs and the IISc must rise to the challenge of quality and open education posed by the nation's unprecedented and rapid economic growth, and the opportunities this provides for globalising India's pool of scientific and technical talent. Together, everyone will prosper.

Acknowledgements

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