DESIDOC Journal of Library & Information Technology, Vol. 32, No. 6, November 2012, pp. 459-467

E-Learning Technology in the ICT Era: Application to Technical Education

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ABSTRACT

In the information technology era, the technical institutions have radically changed the information environment. Information and communication technology (ICT) has created a new opportunities to effectively store and transmit the digital video over networks. E-learning will be introduced as an integral part of an environment where teaching is transformed and where learning is an ongoing, creative process.[1] Along with the basic concepts of e-learning technology and its applications to the technical education using software's and hardware requirements, 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 National Programme on Technology Enhanced Learning (NPTEL) project have been (i) higher education, (ii) professional education, (iii) distance education, and (iv) continuous and open learning,[2]. The E-Vidya solution is deployed on a local high capacity server of required specification where it can be installed in each college campus. Client computers access the streaming media content over the standard high speed campus LAN using a web browser and media player plug-in.

Keywords: E-learning, information and communication technology, National Programme on Technology Enhanced Learning, e-vidya, e-learning technology

1. INTRODUCTION

The advent of information technology, advancement of science and literature and exponential growth of knowledge have made the knowledge storage device undergo a sea change in the second half of the 20th century making the world into a global village. The knowledge production and dissemination in the world have found a sea change in this information era. The present era is popularly known as 'information era', where there is an emphasis and importance for information. The new technological applications especially information and communication technology (ICT) have accelerated the research and development and led information explosion. The combinations of different technological disciplines such as computer technology, information technology, telecommunication technology, satellite technology, digital technology and electronics have contributed to the emergence of ICT. The ICT applications transformed the traditional libraries into electronic libraries or digital/virtual libraries. The emergence internet as a new media of information delivery triggered proliferation of web-based resources. The increased use of internet and phenomenal increase of web-based resources stimulates web-based potential services that enforce the print media that transforming into electronic media.

2. MEANING OF E-LEARNING

E-learning is defined as instruction delivered on a computer via internet or CD-ROM. It can be self-paced or instructor-led and includes media in the form of text, streaming video, and audio and builds user knowledge to improve organisational functioning. E-learning commonly refers to training delivered electronically in an organisational setting while online learning is used to differentiate courses delivered via the internet in educational settings[3].

E-learning is an approach to facilitate and enhance learning through both computer and communications technology. Such devices can include personal computers, CD-ROMs, digital television, PDAs and mobile phones. Communication technology enables the use of the internet, e-mail, discussion forums, collaborative software, and team learning systems[4].

Received 29 August 2011, accepted 13 December 2011, online published 19 November 2012

With the e-learning in school education and the popularisation and application of enterprise training, the e-learning is considered to be a computer, multimedia and network-based, teacher-led and student-centered teaching mode of the new and also in practical applications, e-learning also refers to the information technology environment in the teaching and learning behaviour[5].

3. BENEFITS OF E-LEARNING

(a) Reducing the administrative load by making routine information available online. This will release more time for other activities.

(b) Making communication easier with individual students and groups of students

(c) Making it possible to use a wider range of resources that may otherwise be too difficult or expensive to use

(d) Motivating and supporting students to take responsibility of their own learning

(e) Supporting an increasingly large and diverse student population with little increase in teaching time.

(f) Releasing time for more active, engaging and interactive forms of teaching

(g) Making it easier to amend and update materials

(h) Contributing to quality assurance agency institutional audits[6]

(i) In many contexts, e-learning is self-paced and the learning sessions are available 24x7. Learners are not bound to a specific day/time to physically attend classes. They can pause learning sessions at their convenience. High technology is not necessary for all online courses. Basic internet access, audio and video capabilities are common requirements.

(j) Instructors of the highest calibre can share their knowledge across borders, allowing students to attend courses across physical, political and economic boundaries. Recognised experts have the opportunity of making information available internationally, to anyone interested at minimum costs[7].

4. INFORMATION TECHNOLOGIES AND E-LEARNING

Teaching, learning and libraries continue to be shaped by information technologies. The benefits are many: improved access to a greater variety of resources; enhanced communication; interaction; more flexibility; and reduced barriers of place and time. Information technologies are of value when they enable interactive learning and strengthen the social connections among faculty and students; when students have access to a wealth of online resources and experiences. But the sheer enormity of the web, and online research databases and e-resources licensed by engineering libraries can overwhelm students, even this Google generation! Today's engineering student is online across campus or across the world, studying and working beyond 'normal' hours. It is more important and more difficult to develop programs and services online that match student's needs and capabilities. It is found that the use of technology in teaching and learning enriches the interaction, access, feedback and support among teacher and students. It is crucial for faculty and librarians to have guidelines for online learning as more universities offer e-learning courses. The challenge of 'distance education' is to bring education to students and all the instruction supports that happen on campus. What takes place in the library and in the classroom must be transferred to an online environment. This can be accomplished when course faculty and librarians work together to develop curriculum and support services that engage students. Care must be taken to be deliberately attentive to the learning needs of students online. E-learning is still learning! and students and faculty must be able to meet (virtually), explore, search, analyse, respond and react. Librarians, faculty, and IT staff must monitor student learning to gauge the effectiveness of the technology, course and service design and delivery. In Indian contest many engineering faculties are using course management software (WebCT, Blackboard, etc.)[8]. The development of IT employed to provide distance education have resulted from a 'pushpull' relationship between providers and the public: technological advances have created awareness and demand among users, while usage has pushed providers to further develop technologies. The new technologies have also made distance education courses more convenient and better suited to the needs of different students[9].

Today's librarians must create an engaging setting for teaching and learning by offering a welcoming library space, a wealth of online resources, combined with librarians' expertise and collaborative instruction programmes. Rapid advances in information technologies, new methods of teaching and learning, and the changing makeup of university student populations are impacting the academic library. Working together, librarians and faculty can develop active learning experiences for students, and provide opportunities to integrate resources and discovery. Meeting the information literacy needs of students is best done by integrating library instruction with the course curriculum. This involves collaborative (faculty-librarian) planning, design, and teaching to create a learning environment that challenges students to discover and test their own ideas and research findings. Librarians and faculty share common goals for student success. Mastering of

information literacy and information technology skills equips students to become independent life-long learners[10].

E-learning technology can setup virtual universities, as shown in Fig.1. Virtual universities are institutions that offer most or all of their instructions via technological means and are distinguished by their nearly-exclusive use of technology as the educational delivery device. It is important to note that even non-networked transmissions, whether digital or analog, may incorporate elements of digital network technology. As new types of organisational arrangements emerge, challenges to the flexibility of the higher education community may continue.

For now, distance education providers are offering traditional and nontraditional students alike the opportunity to pursue college education through a variety of arrangements. The computer is the most versatile of distance education instruments, since it can incorporate or perform the same function as a television or telephone, as well as providing more interactivity, delivering more content, and supporting more comprehensive services than any other single medium. Computers can be used to transmit texts and graphics, connect users in a variety of real-time and asynchronous dialogues, deliver messages between users, and receive both audio and video transmissions. College students seem generally positive about the internet and its impact on their educational experience. The majority of college students have a positive attitude toward the internet and its communication tools. They are comfortable with internet communication, and even report finding enjoyment while using it for academic and personal reasons. Their internet habits are split between academic and social uses, and they find it functional for both purposes. Distance educators provide access to selected library resources in digital form for their classes.

These selected resources may be designated as electronic reserves, or “e-reserves,” similar in concept to the use of reserve materials for on-campus classes, which the instructor sets aside for outside reading to supplement primary course materials. These or other e-resource materials are sometimes made available to remote-site students[11].

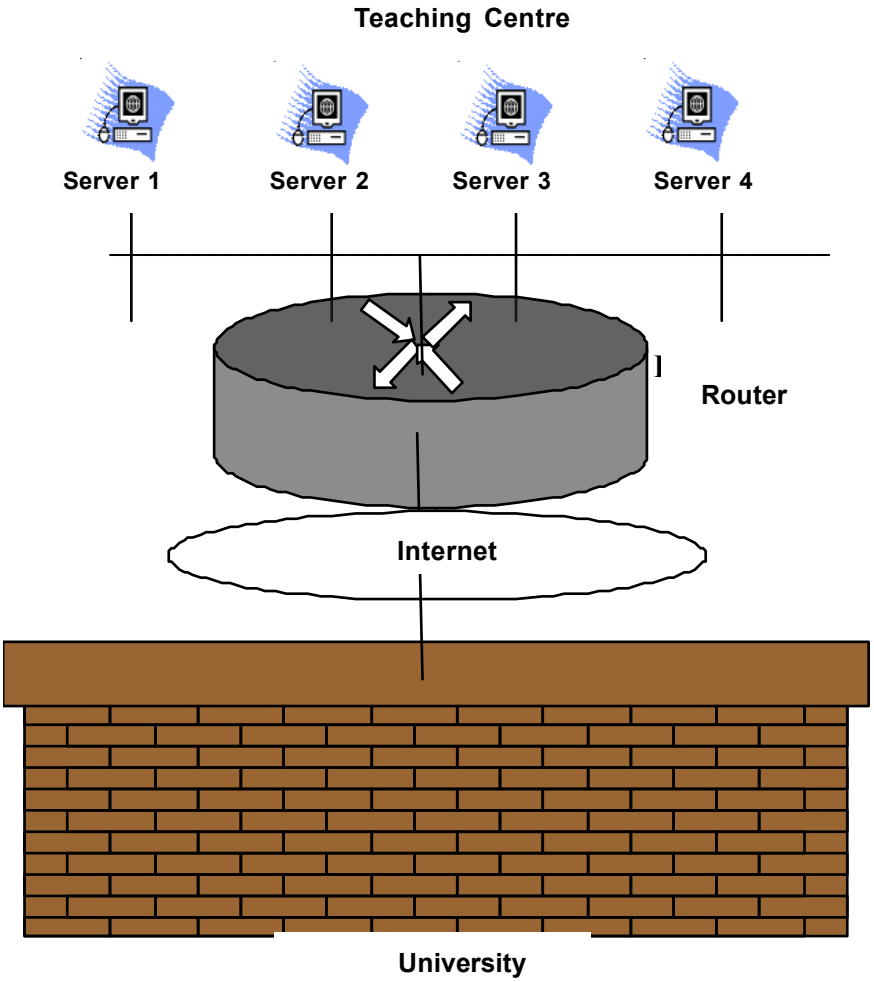


Figure 1. Virtual universities structures.

5. LIFE-CYCLE OF E-LEARNING PROCESS

To reason the need for standards and interoperability in e-learning systems, one should be aware of the lifecycle of the e-learning process and have an overview of the components of e learning systems and their functionality. The stages of a learning process present the building blocks of an e-learning environment and provide a general model that comprises of the different services that e-learning technologies provide. How the building blocks fit together into an overall e-learning application infrastructure and give a functional overview of the processes that make up an e-learning environment is explained.

The life-cycle of the e-learning process from the planning and preparation of a course to the consumption by the learners is depicted in Fig. 2. The life-cycle, comprises of four phases, namely: design phase, where the targets and requirements are specified, the production phase, where content is produced, assembled and packaged for distribution, the deployment phase, which requires the collaboration of learners in order to distribute the appropriate content per case, and the assessment phase, where the outcome of the whole process is evaluated.

For the successful design of a learning process one should first define the required features of learner's profile and the recommended competencies. It should also specify in detail the educational targets to be achieved by the end of the learning process. The production phase integrates the production of content modules, their build-up based on the initial design, and the packaging of the content to be delivered. The deployment phase that follows should consider the ability of users to access the content and collaborate during the learning process. The learning process ends up with the assessment of learners through tests and other activities and of the process itself through evaluation forms. At the end of every phase useful information is collected and feed back to every previous phase of the process. This facilitates the improvement of the whole process and leads to better solutions for learners and educators. As an example, the information gathered during the deployment phase, which concerns actual learners' needs and level of satisfaction is used as an input in the production phase, to reassemble learning objects and produce more competitive packaged solutions[12].

6. NPTEL: NATIONAL PROGRAMME ON TECHNOLOGY-ENHANCED LEARNING

National Programme on Technology-Enhanced Learning (NPTEL) which is an initiative by seven Indian Institutes of Technology (Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras, and Roorkee) and Indian Institute of Science (IISc) for creating course contents in engineering and science. NPTEL as a project originated from many deliberations between IITs, Indian Institutes of Management (IIMs) and Carnegie Mellon University (CMU) during 1999-2003. A proposal was jointly put forward by five IITs (Bombay, Delhi, Kanpur, Kharagpur and Madras) and IISc for creating contents for 100 courses as web-based supplements and 100 complete video courses, for forty hours of duration per course. Web supplements were expected to cover materials that could be delivered in approximately forty hours. Five engineering branches (Civil, Computer Science, Electrical, Electronics and Communication, and Mechanical) and core science programmes that all engineering students are required to take in their undergraduate engineering programme in India were chosen initially. Contents for the above courses were based on the model curriculum suggested by All India Council for Technical Education (AICTE) and the syllabi of major affiliating Universities in India.

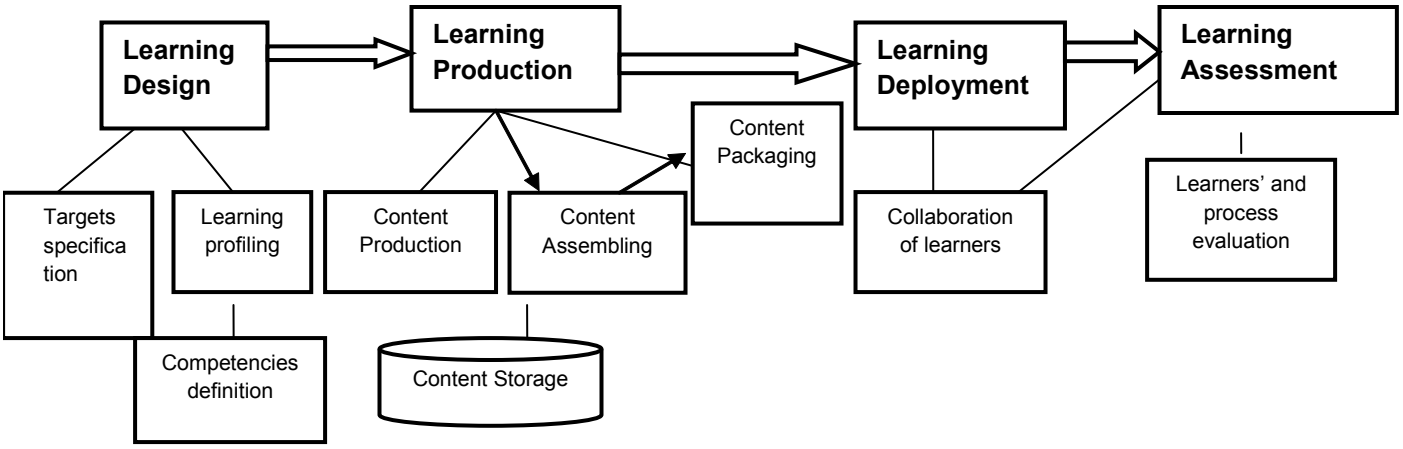


Figure 2. Life-cycle of the e-learning process.

6.1 Objectives

Manpower requirement for trained engineers and technologists is far more than the number of qualified graduates that Indian technical institutions can provide currently. Among these, the number of institutions having fully qualified and trained teachers in all disciplines being taught forms a small fraction. A majority of teachers are young and inexperienced and are undergraduate degree holders. Therefore, it is important for institutions like IITs, IISc, NITs and other leading Universities in India to disseminate teaching/learning content of high quality through all available media.

The NPTEL would be among the foremost and an important step in this direction and will use technology for dissemination. India needs many more teachers for effective implementation of higher education in professional courses. Therefore, methods for training young and inexperienced teachers to enable them carry out their academic responsibilities effectively are a must. The NPTEL contents can be used as core curriculum content for training purposes. A large number of students who are unable to attend scholarly institutions through NPTEL will have access to quality content from them. All those who are gainfully employed in industries and all other walks of life and who require continuous training and updating their knowledge can benefit from well-developed and peer-reviewed course contents by the IITs and IISc.

6.2 Implementation

There are two committees, the National Programme Committee (NPC) headed by the Joint Secretary, Higher Education, MHRD and the Programme Implementation Committee (PIC), headed by Director IIT Madras. The NPC oversees implementation of the programme and offers policy guidelines and financial structure. Some of the NPC members are also members of the PIC. The PIC enables the smooth functioning of the project in several phases and takes care of content creation and technology implementation. Members of the PIC meet periodically (about once every three months) to study the progress and issues related to coursework development. In each IIT/IISc faculty are nominated as TEL coordinators to interact with their colleagues and encourage them to prepare course materials and offer technical and financial assistance using funds sanctioned for that purpose.

In addition, two National coordinators, one for web-based development and other for video lectures offer assistance and oversee the National programme. Groups are formed for solving specific technology or pedagogy-related issues and arrive at general guidelines for faculty preparing course materials. In the first phase of the programme about 350 faculty members in all partner institutions worked together to deliver lecture contents. In the next phase this is likely to increase to well over 1000 faculty. Other institutions such as NITs and major university faculty are also likely to participate.

6.3 NPTEL Projects

6.3.1 Aim

To increase the competitiveness of Indian industry in the global markets by improving the quality and reach of engineering education.

6.3.2 Formats

The web formats available are:

- Web Formats
- 2D and 3D animations
- Interactive codes
- Video clippings
- Voice supplements
- Easily downloadable format

The video format available are:

- Live class room sessions
- Chalk-and-talk
- Tablet writing
- Power point presentations
- Interactive codes

6.3.3 Phase-wise Programmes

In phase I, which was completed recently, the course materials have been developed for approximately 129 web courses and are accessible freely through the website (http://nptel.iitm.ac.in). Lecture contents are also being made available for 114 video courses (Fig. 3). Both the web and video courses cover five major engineering disciplines and the core science curriculum that all engineers must have, and are distributed are given in Table 1.

The numbers are likely to change soon as the website is being continuously updated. The content generation is spread across all eight institutions. The video content is available in MPEG-4 format with a bit-rate of 512 kbps with H.264 compression for streaming through the Internet. They are accessible freely through the YouTube channel (http://www.youtube.com/iit). Web contents and access to embedded video lectures from You Tube are available free of cost through the website http://nptel.iitm.ac.in. NPTEL acknowledges with gratitude the free bandwidth offer for hosting the academic channel by Google Inc. (Fig. 4).

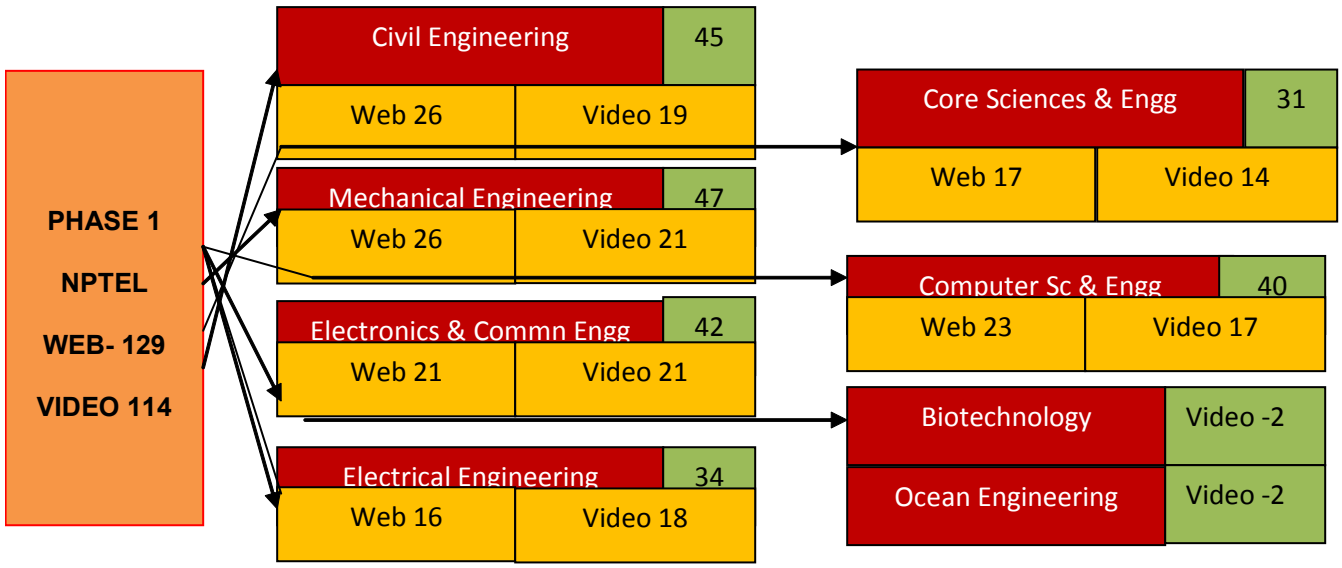
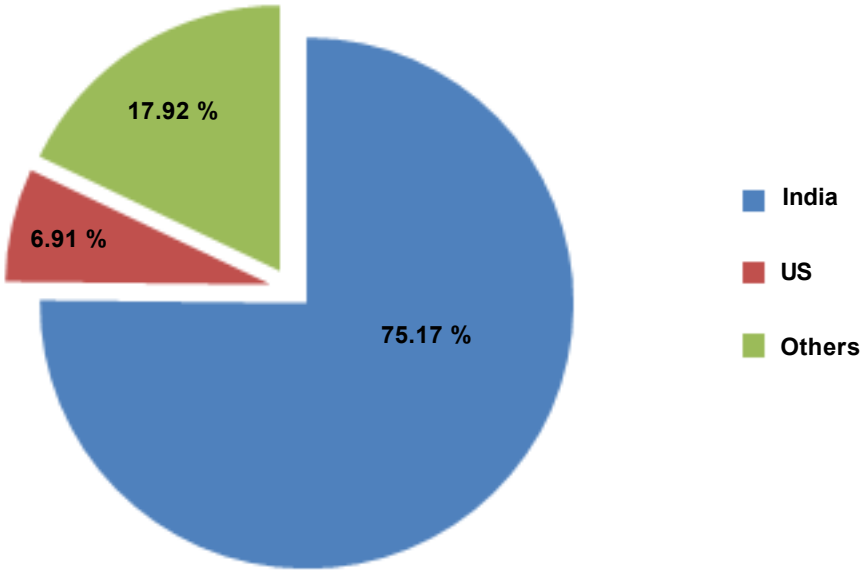


Figure 3. Phase-wise programme.

Table 1. Discipline-wise web and video courses

Discipline	Web	Video
Core Science	17	14
Civil Engineering	26	19
Computer Science & Engineering	23	17
Electrical Engineering	16	18
Electronics and Communication Engineering	21	21
Mechanical Engineering	26	21
Biotechnology	0	2
Ocean Engineering	0	2
Total	**129**	**114**



Source: Google Analytics

Figure 4. User statistics.

6.3.4 Courses Proposed—UG and PG Level

The courses proposed at UG and PG level are shown in Fig 5. The copyrights are owned jointly by the MHRD, IITs/IISc and the faculty. The MHRD has encouraged faculty to convert their electronic content to text books in various engineering and science subjects (which will not affect what is freely available). The rest of the issues are being studied carefully at present. Barring a few courses, the rest of the materials are likely to be distributed under a Creative Commons license in the future[13].

7. E-VIDYA

7.1 Proposed Solution

VTU (Visvesvaraya Technological University) e-learning extensively explored over the last several months various options for deploying NPTEL. The VTU and other contents at VTU affiliated college campuses. Terra Incognitus Systems Research Alliance (TISRA), Bangalore in association with VTU E-learning Centre with hardware platform support from Sun Microsystems, have evolved an advanced e-learning deployment solution called E-Vidya. E-Vidya is a custom designed using proved open source technologies to support the following:

- NPTEL media content (129 courses)
- VTU media content (50 courses)
- Advanced Web 2.0 content management and community management
- Moodles–LMS
- Education content in Java solaris, etc., of Sun Micro system

All necessary software for using the E-Vidya solution is freely available in open-source. The only tools needed on the client computer are the widely used open-source and free Mozilla Firefox web browser and the free open-source VLC Media Player (with the VLC Mozilla browser plug-in). There is no restriction on the client computer operating system or hardware any multimedia desktop PC or laptop is sufficient for accessing content from the E-Vidya server.

The users can access the videos of subjects of their choice any time in a campus network environment. Deployment of this video streaming server in a campus LAN supports asynchronous learning. If the campus is WiFi connected, then the video streams can also be accessed through handheld devices such as mobile phones and internet tablets. Additional course materials, as and when produced or available, can also be loaded.

E-Vidya also comprises of open sources LMS called Moodle. Under Moodle provided e-contents of NPTEL, SUN, and VTU. So the same streaming server is available for video on demand streaming as well as moodle supported e-learning[14].

7.2 Hardware and Software Requirements

The hardware and software reqirements are as shown in Table 2.

8. CONCLUSIONS

Changes in teaching and learning combined with advances in Information Technologies have led to the concept of information or more appropriately, a Learning Commons. The technological advancements in ICT have

PHASE II & III (2007-2012)

Branch	Total no. of courses
Aerospace Engineering	30
Chemical Engineering	60
Chemistry & Biochemistry	70
Mathematics	60
Materials & Metallurgical Engineering	60
Management, Social Sciences & Design	60
Biotechnology	60
Ocean Engineering	30
Textile Technology	20
Nanotechnology	30
PG Level Courses for branches covered in Phase 1 (Civil, Mechanical, Computer Sciences, Electrical, Electronics & Communication	20 100
Total	**600**

Figure 5. Courses proposed at UG and PG level.

Table 2. Hardware and software requirements

S. N0.	Description	
1.	Streaming server and Moodle e-learning (As per Sun Matching Grant Program)	Video content management system Moodle open source LMS, Solaris OS, Mozilla browser, VLC media player
2.	Sun SPARC enterprise T5120 Server, 8 Core 1.2 GHz ulstraSPARC T2 processor. 128 MB server processor, 16 GB FBDIMM memory (8*2 GB), 2*146 GB RPM SAS disks, 1 DVD+/-RW. 4-10/10/100/1000 Ethernet ports, 1 serial port, 4 USB ports 1 dedicated PCI-E low profile slot, 2PCI-E low profile or XAUI(10 GB Ethernet) slots 2 (N+1) 720W power supplies Solaris 10 pre installed.	NPTEL video course 129, VTU video courses 25
3.	Sun (TM) storage j4200 array, localised power cord kit north american 4* Internal 500GB 7.2Krpm SATA HDD 3.5' Sun Storage Tek (TM) PCI-X SAS Host Bus Adapter	E-Learning courses, NPTEL 129, VTU 30, Sun academic initiateves 50

created a new opportunity effectively store and transmit the digital video over networks. The new ICT technology enables video to be converted into MPEG4 format and new searching and indexing of digital video contents enables efficient usage of videos.

In the context of e-learning, the media streaming solutions offers an excellent technology where, digital videos of complete courses are processed and stored in MP4 format in a high speed streaming server which is managed by a content management software and renders streaming of videos to the users in order to efficiently provide access to the users and manage users demand a fool proof video content management system is most essential. This software helps to choose the video specific courses and renders them on a Real player.

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