DISTANCE EDUCATION FOR ENGINEERING AND TECHNOLOGY IN DEVELOPING COUNTRIES

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Abstract

In the current information age, a nation's economy is determined by the number of suitably trained people in information technology. This requires an infrastructure of modern educational institutions to educate the younger generation for the next millenium. In the absence of such an infrastructure, developing countries can employ new modes of distance education based on multimedia technology and Internet which make it more accessible and at the same time more effective and economical. The purpose of this paper is to list the tools and technologies available for distance education and analyze the ways in which a developing country like Pakistan may use these to meet the growing need of educated workforce. The current state of education in the areas of engineering and technology in Pakistan is reviewed and its efforts in distance education is also discussed. It is suggested that other developing countries can use similar modes of distance education to educate their manpower to improve their nation's economy for a better standard of living.

1. Introduction

Undoubtedly a nation's development depends on a skilled and educated workforce who can develop the resources of their country efficiently and help maintain a sound economy for its citizens to enjoy a decent standard of living. As the new millenium is the age of telecommunications, high speed computers and multimedia, an infrastructure of modern engineering and technology institutions is needed to educate the younger generation to respond to the growing need of suitably trained manpower. The information age as it is called is based on computers and networks that interconnect them. An essential requirement for any nation with ambitions to establish a strong position is to have an ubiquitous intelligent, switched, broadband network over which new services can be delivered to end-customers in a responsive and cost effective manner. In economic term this will be 21st century equivalent of today's thruways and their access roads. According to one estimate, by the turn of new millenium 40% of world will be connected to world wide network called the Internet. The information age has also made our world a global village where a portion of the design work for a commercial product is being done in Europe, Japan or US, manufacture in Mexico or Far East and have the software written in India or Pakistan. India earns [1] over $700 million yearly from an estimated $400 + billion sales pool of global information technology while Pakistani software houses exported only $23 million. It is suggested [2] that a developing country like Pakistan can end its budget deficit and

provide employment for its younger generation by joining in the digital era of the information age. According to a United Nations Development Program (UNDP) INFO 21[3], information and technology communication Technologies are not only a significant factor in the performance and growth of economics but they also represent a novel and effective tool to help advance sustainable human development. These technologies allow faster delivery and a more adapted content of technical assistance in a variety of sectors ranging from distance education, telemedicine, environmental management to strengthening of participation strategies and the creation of new livelihood. This can be achieved by a firm commitment to information technology on the part of the governments of the developing countries, the private sector and others interested in making a sound infrastructure of educational institutions, to educate the younger generation in information technology.

II. State of Engineering & Technology Education In Pakistan

Pakistan is one of the fastest growing country of the South Asia with a population growth of 2.8 percent . According to 1995 estimate it has a population of 131.5 million and is the seventh most populous country in the world after China, India, Russia, USA, Indonesia and Brazil. Although it has recently exploded a nuclear device, its literacy rate remains alarmingly low at the rate of only 37%. Pakistan spends only about 2.2 percent of its GNP on education and has not been very successful for creating jobs for its burgeoning younger generation. According to a recent UNESCO statistics [4], personnel engaged in research and development in Pakistan in 1990 numbered only 54 scientist and engineers and 76 technicians per million of population. In Japan, the same statistics in 1992 was 5677 and 869, and in China for the same year, it was 1128 and 428.

At the time of creation of Pakistan in 1947, there were only two engineering institutions, NED engineering college at Karachi and Maclagan engineering college at Lahore. Now after fifty one years, although the population has quadrupled and the nation's economy has changed from agriculture to semi-industrial, the number of engineering and technology institutions remain one of the lowest for the size of its population. Most of these institutions are state funded and are governed by bureaucratic rules and often suffer from declining educational standards due to budget problems. However since 1990s, a number of high quality education institutions in the private sector have been established with strong emphasis on information technology. A list of some of the institutions in engineering and technology is given below.

- Universities of Engineering & Technologies

There are seven universities of engineering & technology located at each of the four provinces of Pakistan. Five of these universities are public and two are private. Undergraduate and graduate programs in all areas of engineering are offered. The admission is strictly on merit and tuition at the state institutions is nominal. The tuition at the private institutions however is high, although some financial aid and scholarships are available.

- Colleges of Engineering

There are seven colleges of engineering located through out the country offering undergraduates programs in all areas of engineering. Four of these colleges are public and three are private. The admission is on merit basis and some institutions require an entry examination.

- Colleges of Technology

There are nine colleges of technology which are like the vocational schools and offer programs in all areas of trades and technologies. The students enter these institutions after 10 years of schooling and are awarded a diploma on the completion. Almost all of them are run by the state and prepare the student for technician and maintenance jobs.

- Institutes of Computer Science

There are six institutes of computer science located mainly in the four metropolitan cities of Pakistan. These institutes offer programs in computer science and business areas. Most of these institutes are run by private organizations and charge fairly high tuition.

III. What Has Been Done In Information Technology

Number of steps since 1990 have been taken by the Pakistan government and private sector to increase the number of institutions and for educating people in information technology. The most prestigious institutions like Lahore University of Management and Ghulam Ishaq Khan Institute of Engineering Science & Technology and others were started in the private sector and remain less accessible due to the high cost of education. Other initiatives taken by the government and private organizations to impact engineering and technology education are given below:

1. The Allama Iqbal Open university has recently started to teach programs in computers and electronics via distance education. It has been educating and awarding degrees in various non technical areas by distance learning since 1974. It has not started engineering & technologies programs yet.
2. The Foundation for the Advancement of Science and Technology (FAST) has established three institutes of computer science and offers B.S. degree in computer science to over 700 students. FAST was founded in 1980 as a private national institution to promote and accelerate the study of pure and applied science and technology in Pakistan.
3. The government of Pakistan Computer Institute has recently started a program of revising the curricula of the four provinces by placing greater emphasis on computer education and on computer linkage with all universities.
4. EDUNET [5] has been successfully installed in 1997 to link six girls government schools in Lahore area. It is the first educational computer network in Pakistan which was developed

with the help of UNESCO under the UNDP. The emphasis is on the centralization of educational material which in turn means a reduction in the expenditure on educational research. Accordingly, If schools and children from all across Pakistan, from Karachi to Khyber are able to access the most modern and constantly updated informational resources through a highly inexpensive computer network, what need remains to spend millions on independent syllabi research.

5. Number of Pakistani-American organizations including APSENA and PARWAZ have been helping Pakistani institutions in providing technical books, journals, software, scientific equipment and help develop courses for distance learning in engineering & technology.

IV. What Needs To Be Done

Engineering and technology education is expensive because of the highly qualified faculty and state of the art laboratories needed to provide an effective hands-on education. The state of the art labs are expensive to equip, difficult to maintain and continuously need funds in order to stay current. The seemingly easiest way of educating large number of people is to open more institutions and increase the number of students in a class room using the existing resources to its optimum. For instance Ghulam Ishaq Khan Institute of Technology accepts only 135 student from applicant pool of 1500, which can be easily increased. Compare that with some of the universities in the USA enrolling up to 40,000 students. Engineering schools can be started at the existing liberal art universities like Punjab , Peshawar, Karachi, Sindh, Islamabad and others having department in arts and sciences.

This approach of starting new institutions or teaching large number of students will require additional suitably qualified faculty and well equipped labs. According to Dr. Akhter Hasan, of Pakistan Education Department [6], the biggest impediment to a major educational catch-up program in Pakistan is the lack of "committed and technical personnel", and the low social standing of educators. Pakistan with its limited resources and budget problems will find it difficult to provide suitably qualified faculty and well equipped labs to educate younger generation to respond to the growing need of the next millenium.

A relatively inexpensive, yet accessible way of educating large number of students is to use distance learning by making use of indigenous qualified teachers and also using large amount of material developed by the Universities in Europe and USA, some of which is available on the Internet. Universities like Columbia, Cornell, Stanford and Open University of U.K. are some of the notable examples of delivering engineering education via distance learning. According to recent report of National Center for Education Statistics (U.S. Department of Education), it is estimated that by Fall 1998, more than half of all higher education institutions in the U.S. plan to offer distance education courses [7].

V. Distance Education

Distance education takes place when a teacher and a student are separated by physical distance and instructional gap is often bridged with a technology like voice, video, data and print. It is not a new concept and was pioneered by Stanford University in the USA, more than 30 years

ago in response to Silicon Valley's demand to educate high-tech engineers and computer scientists. Soon after the Open University of United Kingdom was chartered in 1969, and is currently one of Britain's largest educational institutions attracting tens of thousands of students of all ages and different backgrounds. In Asia the first open university by the name of Allama Iqbal Open University was established in 1974 at Islamabad, Pakistan, and has been providing education to all those who could not or did not join the formal system of education for one or other reasons.

With recent advances in multimedia technology and availability of Internet, it is more effective and accessible to use distance education for teaching engineering and technology curricula. Question by many people including educators is often raised as to whether students learn as much as students receiving traditional face-to-face instruction. Research conducted by a number of authors like Moore & Thompson, and Verduin & Clark [8] in 1991 showed that teaching and studying at a distance can be as effective as traditional instruction, when the method and technologies used are appropriate to the instructional tasks, there is student-to-student interaction, and when there is timely teacher-to-student feedback.

VI. Advantages of Distance Education

1. Accessible to large number of student audience
2. Meet the needs of students who are unable to attend on-campus classes
3. Involve outside speakers who would otherwise be unavailable
4. Link students from different social, cultural, economic, backgrounds

VII. Technological Options

There are wide range of technological options available to the distance educator and fall into four major categories of voice, video, data (computers) and print [9].

1. Voice can be passive like tapes or radio. It can be also interactive like telephone or audio-conferencing.
2. Video can also be passive like still images, pre-produced moving images and a videotape. In interactive video real time moving images can be combined with audio-conferencing and one-way or two-way video or with two way audio.
3. Data is used to describe a broad category of instructional tool dealing with sending and receiving information electronically with computers. The rapid development of computer networks and dramatic improvements in the processing powers of personal computers have made the computers a dynamic force in distance education, providing a new and interactive means of overcoming time and distance to reach learners. Computer applications for distance learning are varied and include Computer assisted Instruction (CAI), Computer-managed Instruction (CMI), Computer-mediated education (CME) and Computer-Based Multimedia .
4. Print is a basic element of a distance education programs and the basis from which all other delivery system have evolved. Various prints formats like textbooks, study guides, workbooks, course syllabi, and case studies.

VIII. Which Technology is Best For Distance Education

Although technology plays a key role [10] in the delivery of distance education, it is important for the educators to remain focused on instructional outcomes and not on the technology itself. The key then to effective distance education is to focus on the needs of learners, the requirements of the content, and the constraints faced by the teacher, before selecting a delivery system. In most of the cases, the systematic approach will result in a combination of media suitable to the learners. In case of Pakistan, all the options of delivering the education may not be available. Each media, however serves a specific purpose as indicated below.

- A strong print component can provide much of the basic instructional content in the form of a course text, the syllabus and day to day reading and schedule.
- Interactive audio or video conferencing can provide real time face-to-face or voice-to-voice interaction. This is also an excellent way to provide guest speakers and other expertise.
- Computer conferencing or electronic mail can be used to send assignments, messages and other targeted communications to the students. It can also help to increase interaction among students.
- Pre-recorded video tapes can be used to present class lectures and visually oriented content of the instruction.
- Fax can be used to distribute assignments to and from the student, last minute announcements and provide timely feedback.

IX. Educator Task

The educator's task is to carefully select a mix of instructional media among the available technologies options which meet the needs of the student in a manner that is instructionally effective , accessible and economically prudent. In case of programs in engineering & technology the need for lab experiments can be met by requiring the students to spend one month in a year on the campus. This may be an important requirement for all disciplines as it helps the students to have interaction with each other and appreciate the campus life. The lab component in engineering & technology courses can also be implemented partly by the available computer simulation and modeling software. One of the widely used simulation software is developed by Math Works Inc, of USA, for a range of subjects in engineering & technology . Number of Universities in the USA and rest of the world have developed courses based on MATLAB software packages and some of them are available on the Internet.

The success of effective distance education program depends on careful planning of focused understanding of course requirements and student needs. Once these elements are understood in detail, an appropriate technology can be selected. The development of distance engineering program evolves through the hard work and dedicated efforts of many individuals and organizations and its success depends on the consistent and integrated efforts of students, faculty, support staff and administrators.

X. Conclusion

It is clear that in order to improve the economy of a nation and provide jobs for younger generation, a sound infrastructure of educational institutions in engineering and technology is needed to suitably educate a large number of people. It is suggested that in the current age of telecommunications, computers and multimedia, distance learning can be efficiently used to educate large number of people in developing countries. Distance education is effective, accessible and at the same time economical.

In Pakistan nearly all the elements and resources for providing distance education in engineering & technology are available. The Allama Iqbal Open university has been working in this area for a number of years and their expertise and experience should be fully utilized. The EDUNET which has been very successful in linking schools in Pakistan, can be extended to the universities and start delivering engineering and technology education. There is ample material and resources available in the USA and Europe, which can be used to implement number of programs in engineering and technology in Pakistan.

The development of a distance engineering and technology education program in the developing countries depends on number of individuals and organizations and its success on the combined efforts of students, faculty and related administrators. A dedicated and concerted effort on the part of concerned individuals and expatriates of the developing countries are also needed. National oversea organizations of the developing countries can be a very effective linkage and important vehicle to bring the concerned parties together and work toward this noble cause of educating younger people in their countries.

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