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The Role of ICT for Improving Engineering Education in India: Challenges and Opportunities

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Abstract: In today's educational world, Information and Communication Technology has become a vital element for educational reforms. There are several and desirable benefits of Information and Communication Technology (ICT) in Science and Engineering education. Despite advantages of ICT's and its attractive features their role in engineering education is lagging behind with respect to other disciplines of education. A structured online survey methodology was used in this paper which outlines the very important role of ICT, Its scope and merits in educational development in Engineering. Besides that a close look at the challenges related to technology adoption and Utilization is also discussed. Enormous opportunities that ICT can Offer, actions needed to overcome the challenges and the strategies for integrating ICT Engineering Education for effective teaching and learning at all levels of the tertiary educational system in the country is also highlighted.

Keywords: ICT, Tertiary Education, Adoption.

I. INTRODUCTION

Nowadays humans are surrounded by various applications of Science and technology that has strongly influenced our attitudes and lives too. Together Science and technology have altered conditions around a mankind, be it educational, economic or social conditions. In recent years (from 1990's), the use of Electronics, Computer and ICT tools in the process of teaching and learning has become common phenomenon in educational institutions in developed countries. ICT is used in the process of teaching and learning as a medium of instruction and computer science programme and Engineering subjects is being taught and learned nowadays at all levels of the higher education system [1] However, applied science and engineering related disciplines faces plenty of problems at almost all levels of educational institutions and one such problem is to communicate through the channels by which concepts, ideas and information could be disseminated to the learner because effective communication through proper and appropriate media is vital for effective teaching. ICT has been tested and used in developed countries to tackle most of these Problems associated with teaching and learning process. It can be used in the Indian educational system to teach all subjects like Science, Mathematics including engineering also [2].

In spite of the fact that large database of articles and books are written on ICT benefits in education, and the Thousands of conferences (local, regional and international) and workshops were organized to address this issue, ICT technology penetration in Engineering education in particular, and education in general, is still very limited. The Literature reveals that the use of ICT in engineering education in has only just started, but in a secluded manner, in certain disciplines of Engineering, such as electronics engineering, civil engineering, mechanical engineering, Aeronautics Engineering etc. [3]. Although engineering education in all these dissimilar disciplines has some common features and our focus in this paper is to come across at those most frequent challenges that face engineering education in general, the opportunities that are available, and recommendations for the proper use of ICT in engineering education. The paper concludes with recommendations suggested to include ICT in Indian Education system.

II. ICT IN EDUCATION

Educational technology is now omnipresent or we can say Ubiquitous, but without the appropriate pedagogical strategies the potential of these educational technologies is lost. Today the best Technologies available for education purpose are in various forms, and the main chore is to find out, how we can make the optimum use of available technology resources to enhance student learning. The necessity for the development of ICT in education is a global decision and has been a subject of great importance to all mankind. Information Communication Technology (ICT) consists of software, hardware, networks, and multiple media for collection, storage, retrieval, transmission, processing, and presentation of information (, texts voice, data and images). However, Information Technology (IT) which is an element of ICT that refers to creation of data, storing and processing the data including software applications, hardware and software systems [4].

Several developed countries has been garnered the benefits of ICT in their education system in order to revive it, be it primary level, secondary or tertiary level of education Even the curriculum of engineering education has also been affected by the use of ICT and the results achieved have been widely appreciated. The most influential and important role of ICT in education is pedagogical changes by introducing pedagogical tools and it has been proven that modern pedagogy is more effective and successful. Time has come to brace up towards the challenges given by new modern educational tools to refurbish our traditional learning system through development and use of Information and Communication Technology (ICT).

In general, ICTs implementation in educational system can be categorized in three main areas: [5]

(i) The Information and Communication Technology (ICT) components which are implanted in the course for simulation and computation (e.g. Such as MATLAB) to solve linear or differential equations.

(ii) The use of Information and Communication Technology (ICT) to deliver learning courses through educational websites or by using video conferencing or,

(iii) The Use of Information and Communication Technology (ICT) tools like LMS, which enable us to track student learning process.

Objectives to be achieved

- Removing barriers to learning and participation in learning.
- Raising standards of engineering education.
- Improving quality of learning in Engineering Education.
- Preparing for employment.
- Up-skilling in the workplace.
- Every learner should achieve their potential.

III. FUNCTIONALITIES OF ICT IN EDUCATION

i. Planning of Course.

- Courses should be created in accordance with learning objectives-what, why, how.
- Cognitive approach should be used to create the order or hierarchy of cognitive levels for learning objectives.
- Concept maps should be used for course planning and corresponding open-source tools.

ii. Effective writing of question assessment.

- Assessment should be aligned according to learning objectives of a Course.
- Questions related to assessment should be ranging from basic or simple to higher or complex assessment questions (create levels, Apply, analyze, evaluate,).

iii. Production of Scientific Content.

- In engineering teaching & learning scientific content such as simulation or animation would Benefits a lot.
- How to find suitable visualizations for your course.
- Visualizations of learning content produce effectively teaching.

iv. An active-learning classroom.

- The objective of active-learning and how to achieve it.
- To create a Particular active-learning techniques such as peer to peer learning.

v. what, why, and how to create Flipped classroom

- Need to Introduce Asynchronous mode of learning (videos, Spoken Tutorials.)
- Group Discussions activities for students based on above content.
- To Promoting collaboration among students.
- To promote peer to peer learning.
- T creates interactive sessions for student.
- To use online tools like blogs, Wikis and forums in order to promote Collaboration among student.
- Evaluating effectiveness of teaching strategies.

IV. ICT ADVANTAGES

Different studies has been carried out in various countries to highlight the importance of ICT at higher education level, as it will play a key role in transforming the shape of higher education There are several advantages in using ICT in universities and them are visible as follows.

Lifelong Skills

Students may have the option to select learning materials that meets their level of interest and knowledge. Also, Self-paced learning modules permit students to study at their own pace and develop computers and Internet knowledge and skills which will help them throughout their lives and careers [6].

Reduces development time

The content is directly written by the subject matter expert by using an authoring tool under the supervision of instructional designer. This way an author can cut down few steps in processing and thus reduces overall development time.

Cost-effective

There is no need to spend extra money on sophisticated tools in order to create the subject matter, because it is the responsibility of the Subject Matter Expert and Instructional Designer to write content directly using rapid authoring tool. Some

of the effective and user-friendly authoring tools available in the market that don't require development experience, such as Storyline, Captivate, and Lectora etc Rapid eLearning can also be cheaper to produce due to the reduced development time.

Direct Expert input

The content written by the Subject matter expert have less chances of being misinterpreted by Instructional Designer because an expert is primary author of the content being produced, which means he might be having ownership for the content he produced and this way his engagement in the content creation is likely to increase [7].

V. CHALLENGES

- i. ***Equal access to learning for all:*** One of the key issues that an Institute faces and needs to address in its use of ICT or in installing and running, and ensuring equal access to learning for all types of students. This is in particular with the disabled students and disability may range from colour blindness, low vision, dyslexia and attention deficit disorder to short-term memory loss, hard of hearing, central-field vision loss and hand tremor in much older learners. There must be some sizeable population of students with disabilities who are struggling to use the Web .E.g. access class activities online and course material.
- ii. ***Lack of Instructional Design methodology:*** Most of the projects related to e-learning require the involvement of instructional designer, in order to help the subject expert to author the content, without whom the process results in poor organization of information and incomplete pedagogical integrity of the final product because Instructional Design methodology is the key to how content should be understood and retained.
- iii. ***Time and effort constraints:*** Faculty are normally busy with their daily schedule of lecture sessions, maintaining records, making question paper setting, answer sheet correction, interacting with students, conducting seminars , Quiz sessions, discussion forums, assignment checking etc. The basic Challenge is that they have to learn the paradigm initially, then prepare the course content according to the instructions and the various assessment documentations as per the formats compatible to the ICT tool courseware within the available time frame [8]
- iv. ***Lack of Motivation:*** The engagement of both faculty and student engagement is closely linked to the quality of the learning and both of them can lose motivation if the quality is skipped. Faculty need to be motivated with financial and non-financial motivational strategies in order to maintain a positive attitude toward ICT training skills for building a learning culture within an institution which may result in increased positive work attitude and least resistance towards new form of learning.
- v. ***Broadband Speed:*** In India the system of education is struggling with numerous problems ranging from infrastructure deficient, shortage of skilled manpower, lack of funds and severe absence of precise vision. Higher Education Institutions are not at par with other parts of the world at higher education level, and because of this most of the India's top ranking Institutes are showing low performance both in Engineering education and research as well. As a developing country India is facing troubles in its higher education especially engineering Education. Some of the points are as follows
 - Very Low broadband speed Connections (see Table 1)
 - Problems in handling Practical's via ICT
 - Teachers Lack of motivational.
 - No or very little technical support.
 - Reluctance to change the learning style.

Rank	Asian Country	Internet Users % Asia	Broadband Download Speed June-2015
1	Singapore	0.3 %	121.25 Mbps
2	Hong Kong	0.4 %	104.0Mbps
3	Japan	7.9 %	85.19 Mbps
4	South Korea	3.3 %	59.08 Mbps
5	Taiwan	1.3 %	48.77 Mbps
6	China	46.3 %	31.57 Mbps
7	Thailand	1.5 %	20.08 Mbps
8	Vietnam	3.0 %	17.14 Mbps
9	Tajikistan	0.1 %	14.14 Mbps
10	Bangladesh	2.9 %	11.3 Mbps
11	Nepal	0.3 %	8.31 Mbps
12	Bangladesh	2.9 %	11.3 Mbps
13	India	17.5 %	7.29 Mbps
14	Pakistan	2.1 %	4.05 Mbps

Table 1. Internet Usage and Broadband Speed Statistics in Asian Countries June 2015.

Vi. **Pedagogical Issues.** Since, technology itself will not lead to any change; teachers must ensure its integration into their curriculum to bring the potential change into the education process. Teachers should have knowledge about relevant ICT tools, and how to use them in their teaching process effectively. Several IIT's (IIT Kharagpur, IIT Bombay, and IIT Delhi) offer teacher training programmes, which focuses on different pedagogical strategies and issues to be addressed. Teachers participating in such programmes will learn different approaches for teaching with ICT tools and to apply them in designing course material and activities.

The main objectives of Teachers training Programmes is that teachers must understand their responsibility in technology-oriented classrooms, Hence, self-efficacy and attitude towards technology play an important role to develop techno-pedagogues . The professional growth of teachers needs to be given more importance, so there need to be congruence between Institutional Curriculum and Teachers training Programme. Otherwise, if teachers are not ready they would not be able to utilize their expert knowledge for designing effective teaching –learning process, assignments and project work. Thus, Change in teachers attitude and education is difficult and tedious task which involve comprehension, anxiety, Fear, caution, and contemplation, workload, Time etc. However, to bring effective change in education is only possible when we can bring changes in the management of teacher's education programs [9].

VI. OPPORTUNITIES

The use of ICT will also address some important issues such as:

- Potential to overcome barriers in Engineering – Time, Pace, and Place.
- Wider participation of Students - Removing distance barrier.
- Ability to modify learning to individual needs.
- ICT support tools - Assistance for physical disabilities and learning.

i. **Internet Growth**

If we see the growth of Internet, In Asia, India alone has Internet penetration population rate of 28% which accounts for 22.6% percentage of Internet users of Asia in a span of just 15 years see (Table 2) . Therefore, within a span of few more years we will witness more Internet penetration usage across the country, which creates an opportunity to spread education and

include ICT in engineering education also. Though India has the second-highest number of Internet users in the world after China, its online penetration rate has reached 28.3% percent. It is this Internet growth which will drive users in rural areas and with the availability of low-cost smart phones together with low mobile and internet tariffs it will empower users to study and get access to education anytime, anywhere, and at any place.

Asia Region	Population (2015 Est.)	Pop. % World	Internet Users Dec 31- 2000	Internet Users 30-Jun-2015	Penetration(% Population)	Internet % Users	User Growth 2000-2015
Asia Only	4,032,466,882	55.5%	114,304,00	1,563,208,143	38.8 %	47.8%	1,267.6%
Rest Of World	3,228,154,236	44.5 %	246681492	1,707,282,441	52.9 %	52.2 %	592.01%
World Total	7,260,621,118	100.0 %	360,985,492	3,270,490,584	45.0 %	100.0 %	806.0%

Table 2. Population Statistics and Internet Usage of India (Internet World Statistics, June-2015)

Region	Population (2014 Est.)	Pop. % World	Internet Users Dec 31- 2000	Internet Users 30-Jun-2015	Penetration(% Population)	Internet % Users	User Growth 2000-2015
India (2015)	1,282,390,303	19.24%	5,000,000	354,000,000	28.3 %	22.6 %	6980%

Table 3. Internet Usage and Population Statistics of India.

There is incredible internet user growth which is 6980% in a span of just 15 years (See Table 3) [10]. The internet and applications associated with education is being seen as an opportunity that should be apprehended by higher educational institutes in India especially Universities to leverage change and to transform themselves and the use of ICT has been seen as a revolutionary tool to overcome various challenges which educational sector in India is facing today.

ii. *Educational Data Mining.*

We explained possible potential benefits of Educational Data mining as powerful analytical tool. The Educational data set generated in ICT learning scenario hides the knowledge among itself that is extractable using data mining techniques. The purpose of EDM is to obtain the significant data patterns from an educational system that could be used for strategic planning as well as for other learning gains. It will be helpful in engineering education where EDM will help us to explore relevant information results and can produce diverse perspectives to understand more about the learner's activities during a learning process. The data can be related to student demography or academic that can be used to help instructors. [11]

- To understand learner's behaviour.
- To improve their teaching.
- To enhance curriculums.
- To improve and assess ICT systems.
- To Keep track of Students learning.

VII. CONCLUSION

In this paper, we made an attempt to have an inside look into Information and communication technology as a big leap towards the improvisation of teaching and learning of education especially engineering. The potential of ICT tools to change the scenario of learning from teacher centric to student or learner centered is also discussed keeping in view the challenges, we can face and the opportunities to acquire. However, if Indian educational Institutes will not succeed to obtain the knowledge of ICT to provide modern means of education (teaching and learning), it will be difficult for the outgoing Students of those Institutes to fit into the society governed by technology. Therefore, it is the right time to ponder and efforts should be made by

all the stakeholders (Administration, Faculty, Students) to strive for the inclusion of technology (ICT) into our educational system in order to meet the modern educational criterion to be at par with world class Institutions.

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