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## Information and Communications Technology: An Overview

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### ABSTRACT

*This article reports on the literature associated with practicing teachers' uptake of information and communications technology (ICT). Use of ICT in the classroom: access to resources, quality of software and hardware, ease of use, incentives to change, support and collegiality in their institution/organization and national polices commitment to professional learning and background in formal computer training. The review highlights the role of pedagogy and suggests that teachers' beliefs about teaching and learning with ICT are central to integration. It is suggested that successful implementation of ICT needs to address three interlocking frameworks for change: the teacher, the institution and policy makers. In this framework we discuss empirical evidence of the use of different types of ICT in different subjects and phases of education. This study is vital to make understanding of teacher's how their communicative strengths and weaknesses can affect the teaching and how they can make their teaching more effective with the help of the communication and ICT by using them as per their needs.*

**Key-words:** Information, communication, technology, IT, & ICT.

### 1. INTRODUCTION

ICT present new opportunities for communicating with students. It can make communication easier and more convenient that can play an important role to make teaching methods more effective, easier to understand in a more precise way, etc. It can also resolve the issue of teacher's and student ratio below the standard according to the guidelines of the different educational body of the India, in the newly established educational institute as well as remotest area suffering from unavailability of well qualified teacher's since long time, etc. but students generally value the opportunity for personal contact and conversation with the teacher as well. In a multilingual society like India, teachers struggle with decisions about the variety of languages (ex. English) to use, the standard quality of their English, their English language proficiency and the effectiveness of their communication skills. This study examines teachers' perception of as reflected in their journals.

The emergence of ICT has fundamentally changed the practices of not only business, governance or education but every spheres of human endeavor. As the world population edged to 7 billion in 2011, it has profound implications in every sphere. India has a massive 1.2 billion population (www.censusindia.gov.in, 2011) of which a high proportion of them are young. India has innumerable challenges in terms of infrastructure, socio-economic, linguistic and physical barriers for people who wish to access education. However, it is hoped that ICT can transform the educational scenario in the country. The emancipatory and transformative potentials of ICT in higher education in India have helped increase the country's requirement of higher education through part-time and distance-learning schemes.

It can be used as a tool to overcome the issues of cost, less number of teachers, and poor quality of education as well as to overcome time and distance barriers (McGorry, 2002).

Mooij (2007) states that differentiated ICT based education can be expected to provide greater reliability, validity, and efficiency of data collection and greater ease of analysis, evaluation, and interpretation at any educational level. While the world is moving rapidly towards digital media, the role of ICT in education has become increasingly important. It has transformed the way how knowledge is disseminated today in terms of how teachers interact and communicate with the students and vice-versa. Besides, it can provide networking structures transcending borders and foster empowerment amongst students. But then what has been its impact in the higher educational scenario in the country?

Success of ICT-based education depends upon the teacher's ability to keep pace with the developments since teachers are responsible for quality control, improvement of learning and the aggregate effectiveness of the learning process. The main role of teachers will not be to transmit information and culture, but rather to act as experts and leaders to motivate learning. UNESCO (2002) highlights how the application of ICT could benefit the students (Table 1), employers and the government. While technology can bring about a learner-centered approach, it could also be harnessed for multiple purposes such as increasing the capacity and cost effectiveness of education and training systems and enhance the quality of higher education.

**Table 1: Benefits of ICT in Education**

Student	<ul style="list-style-type: none"> <li>Increased access</li> <li>Flexibility of content delivery</li> <li>Combination of work and education</li> <li>Learner-centered approach</li> <li>Higher quality of education and new ways of interaction</li> </ul>
Employer	<ul style="list-style-type: none"> <li>High quality, cost effective professional development in work place</li> <li>Upgrading of employee skills, increased productivity</li> <li>Developing of a new learning culture</li> <li>Sharing of costs and training time with the employees</li> <li>Increased portability of training</li> </ul>
Government	<ul style="list-style-type: none"> <li>Increase the capacity and cost effectiveness of education and training Systems</li> <li>To reach target groups with limited access to conventional education and training</li> <li>To support and enhance the quality and relevance of existing educational structures</li> <li>To ensure the connection of educational institutions and curricula to the emerging networks and information resources</li> <li>To promote innovation and opportunities for lifelong learning</li> </ul>

(Source UNESCO, 2002)

## 2. HIGHER EDUCATION SCENARIO IN INDIA

India has one of the largest higher education systems in the world consisting of over 712 universities according to UGC as on 05.05.2015 (Table 2). Besides there are 35,863 colleges of higher learning in the country as on September 2014 according to All India Survey on

Higher Education (AISHE). The number of students enrolled in the universities and colleges has increased since independence to 13,642 million in the beginning of the academic year 2013-14 with 1,669 million (12.24%) in the university departments and 11.973 million (87.76%) in the affiliated colleges (MHRD, Annual Report, 2009-10). However, this growth in numbers does not reflect much improvement in the delivery of higher education in the country.

**Table 2:** Classification of Universities (Category-wise) in India

S. No.	Type of Institution	No. of Institution (As on 2006)	No. of Institution (As on 2015)
1	Central Universities	20	46
2	State Universities	217	330
3	Private Universities	8	208
4	Institutions Deemed to be Universities	104	128
<b>Total</b>		<b>349</b>	<b>712</b>

(Source: <http://www.ugc.ac.in>; excluding institutions of national importance)

The higher education system in India continues to suffer due to inadequate access to technology and inequity. However, the application of ICT in higher education has not only brought about diversification in higher education but has also fostered new avenues for international mobility of traditional and non-traditional students. This sense of urgency and the continuous implementation of ICT in higher education has led many universities and colleges into a more action-oriented adaptation approach (Schmidtlein & Taylor 2000). Pedro (2001) observes that the focus is often more on the end product than on the premises and processes behind a well-functioning incorporation of ICT in teaching and learning.

### 3. ROLE OF INDIAN GOVERNMENT

Government of India has taken up major initiatives in terms of content delivery and furthering education through Information and Communication Technology. For instance Gyan Darshan was launched in 2000 to broadcast educational programs for school kids, university students, and adults. Similarly Gyan Vani was another such important step which broadcast programs contributed by institutions such as IGNOU and IITs. Under the UGC country wide classroom initiative, education programs are broadcast on Gyan Darshan and Doordarshan's National Channel (DD1) everyday. E-Gyankosh which aims at preserving digital learning resources is a knowledge repository launched by IGNOU in 2005. Almost 95% of IGNOU's printed material has been digitized and uploaded on the repository.

National Mission on Education through ICT (NMEICT) is a landmark initiative of the Ministry of Human Resource Development (MHRD) to address all the education and learning related needs of students, teachers and lifelong learners. In Indian scenario where there is a vast disparity of educational facilities available in various regions across the country, the Mission envisages to bridge the gap by providing just- in- time quality educational resources and teachers 24×7 to learners irrespective of their social, economic and educational status. The NMEICT was launched on February 3, 2009 at Tirupati, Andhra Pradesh as a Centrally Sponsored Scheme to leverage the potential of ICT in teaching and learning process. The Mission has planned a variety of initiatives aimed at developing and standardizing digital content for Indian higher education segment. The Mission envisions catering to the learning needs of 500 million people in the country. The three cardinal principles of the Education

Policy vis., access, equity and quality are to be served through three major components of the mission:

1. Broadband connectivity to all colleges and universities.
2. Low cost access & computing devices for students and teachers.
3. High quality e- content generation.

There are three guiding philosophies for this effort –

1. No talent of the country should be allowed to go waste,
2. All the services available through the content delivery portal Sakshat should be free, &
3. Freely available material on the web should be used so as to avoid reinventing the wheel.

The objectives of the mission are: Empowering and enabling students by ensuring equity and access to education through the use of ICT; Connecting over 400 Universities and 22,000 Colleges all over India through high-speed data networks; Improving faculty quality by using a unique synchronous training methodology; Ensuring equity by providing access to expensive equipment to students even in remote corners through innovative use of ICT; and Making available e-content and educational videos created by the best teachers across all disciplines for UG and PG classes.

### 3.1 Broadband connectivity to Colleges and Universities

Providing connectivity to the colleges, institutions and universities is a key component of the NMEICT (<http://nmeict.ac.in/>). Around 60% of the Mission budget has been earmarked for the connectivity. Bharat Sanchar Nigam Limited-Mahanagar Telephone Nigam Limited (BSNL-MTNL) combine have been entrusted with the task of providing connectivity under NMEICT Scheme. For further details visit BSNL- NMEICT portal (Table 3) at <http://www.nme.bsnl.co.in/>.

**Table 3:** Connectivity Status under NMEICT

Category	Connected	Contact
Colleges	26000+	<a href="http://www.nme.bsnl.co.in/">http://www.nme.bsnl.co.in/</a>
Polytechnics	2000	Mr. P Baburaj, DGM, NOC Bangalore
University	400+	Mr. K Rajasekhar, Additional GM, SPP Hyderabad

### 3.2 Low cost access & computing devices (ex. AAKASH Tablet) for students

Even the best e-content cannot have a significant impact unless it reaches the vast majority of learners with ease, as and when they demand it. The Mission has funded the development of Ultra Low Cost Computing Devices to enable students, wherever they may be, access to education content. Initially the project was entrusted to IIT Rajasthan, which worked on the specification, design, tendering and procurement of the first version of the Aakash tablet. The Minister of Human Resource Development launched Aakash 1 on October 5, 2011. Subsequently Indian Institute of Technology (IIT), Bombay took over the project pertaining

to (a) Acquisition and Testing of Low Cost Access-cum-Computing Device and (b) Hardware and software optimization of LCAD under the scheme of NMEICT.

The advanced version of low cost tablet called Aakash-2 was launched by the Honorable President of India on the occasion of National Education Day i.e. 11th November, 2012.

As compared to Aakash-1 launched in October 2011, this advanced version has a processor, which is about 3 times faster, memory twice as large, and capacitive touch screen as compared to resistive touch screen.

On these upgraded devices, R&D teams at IIT Bombay have built a multitude of useful educational applications and content. Some important applications are:

1. Interactive lesson building tool 'ProxyMITY'.
2. 'Clicker' application which permits quizzes to be conducted on-line in class rooms in real time.
3. Standard educational contents in pdf and HTML can now be easily stored and read on Aakash-2. As a demonstration, some school books available in digital format from NCERT, and a state board for school students have been ported.
4. A 'Robot-Controller' as a demonstration of engineering control applications.
5. Spoken tutorials can be used on Aakash-2.
6. Some educational animations have been built, and open source software tools are being developed and adopted for creating interactive animations to run on Aakash-2.
7. Programming environment which permits students to use these tablets as a regular computer to write programs in C, C++, and Python.
8. The Scilab package has been fully ported on Aakash-2.
9. Aadhar biometric authentication has been integrated with Aakash-2.
10. Linux Operating System has been ported on Aakash, which is being further optimized (to know more about the Aakash Project visit <http://aakashlabs.org/>).

### 3.3 High quality e- content generation

#### 3.3.1 NPTEL

The National Programme for Technology Enhanced Learning (NPTEL) is a joint initiative of IITs and IISc funded by this Mission provides e-learning through online Web and Video based courses in engineering, science and humanities streams. The Mission of NPTEL is to enhance the quality of engineering education in the country by providing free online courseware.

Over 329 courses are complete and made available in NPTEL website (<http://www.nptel.ac.in>). More than 990 courses in various disciplines in engineering and science are getting generated in phase-II of NPTEL A set of 5 separate DVDs containing ready NPTEL course material -- one each in the areas of Electrical, Civil, Computer Science, Electronics and Mechanical Engineering were distributed to the AICTE approved Engineering Colleges during the dissemination workshop for engineering colleges of NCR Region held on 8<sup>th</sup> October, 2013.

#### 3.3.2 CEC

Consortium of Educational Communication (CEC) has been tasked for e-content generation For UG courses. In phase-I, e-content for 19 UG subjects and in phase-II e-content for 68 subjects are being generated by the CEC in collaboration with its media centers. It is available at CEC E-content Portal (<http://www.cec-ugc.ac.in>).

### 3.3.3 e-PG Pathshala

E-content generation activity has been assigned to University Grants Commission (UGC). The process of content creation has been initiated for 72 PG subjects. The content and its quality is the key component of education system. High quality, curriculum-based, interactive content in different subjects across all disciplines of social sciences, arts, fine arts & humanities, natural & mathematical sciences, linguistics and languages is being developed under this initiative named e-PG Pathshala.

### 3.3.4 Virtual Lab

Virtual Labs is a joint project of twelve participating institutes, being nationally coordinated by IIT Delhi. The basic aim of this project is to design and develop Virtual Lab in various areas of Science and Engineering in order to benefit maximum number of students. The Virtual Labs essentially comprises a user-friendly graphical front-end, working in synchronization with a backend, possibly consisting of a simulation-engine running on a server or actual measurement data or a remotely triggered experiment. It does not require any additional infrastructural setup for conducting experiments at user premises. One computer terminal with broadband Internet connectivity is all that is needed to perform the experiments remotely. Over hundred Virtual Labs are currently ready for use. These labs were dedicated to the nation on 23 February 2012. Over 50,000 students, (in approximately 150 colleges) have used the Virtual Labs and have provided user-feedback through our website (<http://www.vlab.ac.in>).

### 3.3.5 A-VIEW

A-VIEW developed by Amrita Vishwa Vidyapeetham is being used as the collaboration tool for the National Teacher Empowerment Program. Prof. Deepak Phatak, IIT Bombay, leads the National Teacher Empowerment Program to train thousands of college teachers across the nation. More than 36, 000 teachers have already been trained under this programme. It is an advanced multi-modal, multi-platform, collaborative e-learning solution which allows an instructor to teach or interact with a large number of learners transcending geographies on a real-time basis through live audio video streaming and synchronized content sharing and allows the instructor to perform live evaluation of the learners and to get real-time feedback from attendees on the go. It can also act as an online meeting tool that can support online social collaboration and interactions with multiple users from various locations simultaneously.

### 3.3.6 Spoken Tutorial

A Spoken Tutorial is a ten minute audio video tutorial on open source software, created to train our students on important IT topics. Spoken Tutorials are created for self learning, using the pedagogical methods developed at IIT Bombay. The spoken parts of these tutorials are dubbed in all Indian languages, to help children who are weak in English. Using a series of such tutorials, one can learn even a complicated IT topic easily. The main objective of the Spoken Tutorial project is to improve the employment potential of our students. At present, there are about 500 spoken tutorials in English and 2,000 dubbed tutorials in Indian languages. The Spoken Tutorial team also conducts organized workshops using spoken tutorials. Any student or a faculty member from any college can conduct SELF workshops, free of cost, with help, as mentioned in <http://process.spoken-tutorial.org/index.php/Software>.

The FOSSE project provides free support on FOSS (free and open source software) to eliminate the use of commercial/proprietary software in education. The project activities include:

1. Support for Self workshops on FOSS
2. Textbook Companion- to create documentation for FOSS through students,
3. Lab Migration activity to provide help in shifting from proprietary software based labs to FOSS

The FOSSE team promotes:

- a) Scilab to replace Matlab
- b) Python, a scripting language.
- c) OScad to replace ORCAD
- d) OpenFOAM, a FOSS alternative to FLUENT
- e) COIN-OR for optimization.

### 3.3.7 e-Yantra

e-Yantra is an initiative to incorporate Robotics into engineering education with the objective of engaging students through exciting hands-on application of math, computer science, and engineering principles, in order to turn them into engineers who can support a rapidly growing economy. The goal of e-Yantra is to enable effective embedded systems and Robotics education across engineering colleges in India, by

- Providing training for teachers and students -- through workshops where participants are taught basics of embedded systems and programming;
- Engaging teachers and students in hands-on experiments with robots - through competitions where participants are given robots to implement a solution; and
- Helping colleges to set-up Robotics labs/clubs – by awarding a basic set of robots and expert advice to colleges, facilitating setting up of labs, in addition to training their teachers through workshops.

### 3.3.8 ERP Mission

Educational Resource Planning (ERP) mission with IIT Kanpur as lead institute in collaboration with other partners in this project AMU (Aligarh), AVV (Kochi), DEI (Agra), IGNOU (Delhi), IIT Roorkee, JMI (Delhi), NIT Hamirpur, and SMVDU (Jammu), proposes to build, deploy and manage web based software system for use of Indian academic institutes. IIT Kanpur has developed a learning management system (LMS) Brihaspati and the other modules of ERP system are being built around it. Major modules developed are- online admission system, e-portfolio, project management, general accounting system, payroll generation within a institute, purchase and inventory management, library automation, online election management and web hosting management system. For more information about this project visits [http://202.141.40.218/~brihaspati/edrp\\_portal](http://202.141.40.218/~brihaspati/edrp_portal).

### 3.3.9 Pedagogical Programme

This project envisages systematically designing and developing learner-centric curricula, suitable for outcome-based learning for 4 year degree programmes in six major engineering disciplines. Each curriculum document are primarily meant for students, telling them what knowledge, skills and attitudes they should be able to demonstrate on completion of each

course, where to find the necessary learning resources (in addition to approximately 80 pages of in-built course notes) and also providing them with opportunities for self assessment (around 120 – 125 practice problems / assignments with solutions). Used innovatively, these documents can promote self and group learning. Also faculty members, in particular, those who may have to teach such a course for the first time, are likely to find these documents extremely useful.

### 3.3.10 DTH Programme

MHRD is poised to launch the most ambitious programme, '50 DTH educational channels' on 24X7 basis under NME-ICT, to generate and deliver structured education content to reach homes, the most cost effective way. It aims to achieve composite goals of ensuring 'Access, Equity and Excellence' and bridging the digital divide in higher Education. The MHRD DTH programme has the potential to be watched by 67% homes in India. Under this programme Teacher's/SME's shall be delivering 8 hours of live lectures a day/channel and the same will be repeated twice a day to benefit those who miss out the live sessions. The students can seek answers to their queries instantaneously from the teacher during the live transmission or asynchronously if they are viewing recorded lectures. The live telecast will be Multi-casted to enable access through other devices like computers, tablets, and smart phones. The content delivered are to be converted into e-Contents so that viewers can benefit from watching the content on demand at their convenient time, place and pace.

However, NMEICT provide connectivity but has limited bandwidth, but National Knowledge Network (NKN) project is aimed at establishing a strong and robust internal Indian network which will be capable of providing secure and reliable connectivity. Using NKN, all vibrant institutions with vision and passion will be able to transcend space and time limitations in accessing information and knowledge and derive the associated benefits for themselves and for the society. Establishing NKN is a significant step towards ushering in a knowledge revolution in the country with connectivity to 1500+ institutions. NKN is intended to connect all the knowledge and research institutions in the country using high bandwidth / low latency network.

Globally, frontier research and innovation are shifting towards multidisciplinary and collaborative paradigm and require substantial communication and computational power. In India, NKN with its multi-gigabit capability aims to connect all universities, research institutions, libraries, laboratories, healthcare and agricultural institutions across the country to address such paradigm shift. The leading mission oriented agencies in the fields of nuclear, space and defense research are also part of NKN (<http://www.nkn.in/>). By facilitating the flow of information and knowledge, the network addresses the critical issue of access and creates a new paradigm of collaboration to enrich the research efforts in the country. The network design is based on a proactive approach that takes into account the future requirements and new possibilities that this infrastructure may unfold, both in terms of usage and perceived benefits. This will bring about a knowledge revolution that will be instrumental in transforming society and promoting inclusive growth.

The purpose of such a knowledge network goes to the very core of the country's quest for building quality institutions with requisite research facilities and creates a pool of highly trained professionals.

The NKN is a state-of-the-art Pan-India network. NKN is designed to provide high



availability, Quality of Service, security and reliability. It will facilitate the development of India's information infrastructure, stimulate research, and create next generation applications and services.

### 3.4 NKN Application

- ❖ **Countrywide Virtual Classroom:** The NKN is a platform for delivering effective distance education where teachers and students can interact in real time. This is especially significant in a country like India where access to education is limited by factors such as geography, lack of infrastructure facilities etc. The network enables co-sharing of information such as classroom lectures, presentations and handouts among different institutions (<http://www.nkn.in/>).
- ❖ **Collaborative Research:** The NKN enables collaboration among researchers from different entities like GLORIAD, TEIN3, GARUDA, CERN etc. NKN also enables sharing of scientific databases and remote access to advanced research facilities.
- ❖ **Virtual Library:** The Virtual Library involving sharing of journals, books and research papers across different institutions, is a natural application for NKN.
- ❖ **Sharing of Computing Resources:** High-performance computing is critical for national security, industrial productivity, and advances in science and engineering. The network enables a large number of institutions

#### 3.4.1 NKN Services

- ❖ **Generic Services:** Internet, Intranet, Network Management Views, e-Mail, Messaging Gateways, Caching Gateways, Domain Name System, Web Hosting, Voice over IP, Multipoint Control Unit (MCU) Services, Video Portals, SMS Gateway, Co- Location Services, Video Streaming etc.
- ❖ **Community Services:** Shared Storage, e-Mail List to access high-performance computing to conduct advanced research in areas such as weather monitoring, earthquake engineering and other computationally intensive fields.
- ❖ **Grid Computing:** The NKN has the capability to handle high bandwidth with low latency and provision to overlay grid computing. Some of the grid based applications are climate change/global warming, science projects like Large Hadron Collider (LHC) and ITER. The NKN can be the platform to realize many such innovative applications. The Garuda Grid has enhanced its power and stability by migrating to NKN (<http://www.nkn.in/>).
- ❖ **Network Technology Test-bed:** NKN provides test-bed for testing and validation of services before they are made available to the production network. NKN also provides an opportunity to test new hardware & software, vendor interoperability etc. e-Governance NKN acts as a super highway for integrating e- Governance infrastructure such as government data centres and networks. NKN provides bulk data transfer facility required for e-Governance applications. Software Application (LISTSERV), Authentication Service, EVO, Session Initiation Protocol (SIP), Collaboration Service, Content Delivery Service, International Collaborations with EU-India Grid, Global Ring Network for Advanced Applications Development (GLORIAD) etc.

## 4. ISSUES AND CHALLENGES OF ICT

While we glorify the use of ICT in education sector, we also need to assess the problems and

prospects in its implementation. Literature on ICT in education continues to project that it can help improve India's higher education system by providing greater equity, better access and improved quality. There is a growing apprehension that Information and Communication Technology can transform India towards becoming a knowledge society, but then can technology alone enhance the quality of higher education in the country? The penetration of ICT systems in higher education institutions is extremely poor according to a survey of accredited colleges by UGC in 2008 which reveals shortcomings in IT infrastructure. As the majority of Indians living in rural areas have poor access to internet, it is necessary that they are exposed and trained in basic computing skills and ICT utilization.

India's linguistic diversity necessitates the development of content in multiple languages to increase ICT applications. According to the 2011 Census the rural-urban distribution is 68.84% & 31.16% in terms of population where majority of the rural people do not speak English. Therefore, the need to develop content in all the official languages of India becomes all the more important. While there are many challenges in development of local language content particularly due to the absence of script and font standardization, local language computing becomes problematic though not impossible. In a multi-lingual country like India, this standardization becomes even more difficult. However, this needs to be addressed immediately. As ambitious ICT based initiatives in higher education is envisioned, it is necessary to embark on a well-articulated 'Action Plan'.

## 5. CONCLUSION

ICT has made tremendous change in educational comfort-ability, but we are yet to achieve the desired level of IT adoption in higher education in India. The optimal utilization of opportunities arising due to diffusion of ICTs in higher education system presents enormous challenge. Nonetheless, it has become an indispensable support system for higher education as it could address some of the challenges facing higher education system in the country. Of course, technology does not address all communication needs. Students value opportunities to have personal interactions with their teachers and to be an effective teacher, you must be skilled at communicating in many different ways. However, when used properly, technology can augment what you do in the classroom to enhance communication. Moreover, it can provide access to education regardless of time and geographical barriers. Similarly wider availability of course material in education which can be shared by means of ICT, can foster better teaching. While technology can influence the way how students are taught, it would also enable development of collaborative skills as well as knowledge creation skills. ICT enabled education will ultimately lead to the democratization of education and it has the potential for changing education system in India.

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