RESEARCH PAPER

Innovative way of Teaching Computer and ICT using Virtual Laboratory

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ABSTRACT

Any society is as storing as its educational system. Providing proper education to students always has been a challenge to Governments and Educational Institutions. To decide the pedagogy of education is always a matter of discussion in Educational Institutions. Be it face to face class room teaching, teaching through ODL or through electronic mode of education delivery using ICT tools and technologies. In the process of teaching and learning it is always s essential to consider the method of content delivery in such a way that it is more effective and long lasting in terms of final outcomes. This is era of technology and innovations; we are observing everywhere Computers and ICT is being used extensively. In general, Computer and ICT are close and interdependent disciplines. To teach Computer and ICT is a challenge as it practical oriented and need expensive infrastructure in terms of hardware and up-to-date software. Also engagement of learners is key factor which can be achieved by properly planed laboratory exercises for use of applications, programming and implementation. Also in Computer lab, proper utilization of latest concepts like simulation and virtual laboratory are more useful as they offer cost effective, flexible and scalable option of teaching and learning. This paper explains about use of ICT in education, and describe why teaching Computer and ICT by doing and practicing is more effective. Also this paper proposes a Virtual Laboratory based teaching model for ODL institutions.

Key words: *Open and Distance Learning (ODL), Teaching Computer and ICT, Virtual Laboratory, Learning Management System (LMS)*

INTRODUCTION

The world has witnessed very fast development in the area of Computer Science and Communication Technology in last twenty five to thirty year. Almost all the areas of life be it education, industry, governance, financial management, health, agriculture, entertainment or any other area are being affected by computer and Information and Communication Technology (ICT) applications. ICT is a umbrella term and it consists a range of rapidly evolving technologies and applications such as desktop computers, laptop, notebook, and handheld computers, digital cameras, local area networking, Bluetooth, WiFi, Internet, RFID, the World Wide Web, Web Streaming, Multimedia & Animation, Data Mining, Big Data Analytics ,Cloud Computing, IoT and many more. There are many general purpose applications such as word processing, spreadsheets; e-learning and digital libraries, computer-mediated conferencing, videoconferencing, virtual reality, simulator & emulator, social networking etc. have major impact on education planning, development and delivery. ICT has given a boost to 'Open & Distance Learning' (ODL) and provided opportunity to offer consistent, quality education to diverse group of learners. It has bridge the gap between rich and poor as for as quality education content access is concerned. ODL has offered the opportunities to the learners who are working and want to pursue education and sustain them self financially.

The development in the area of mobile devices bridges the gaps between formal and non-formal learning. Furthermore, social networking, gaming and learning apps are opening up opportunities for students to do socially mediated knowledge sharing and learning in different area of education, be it learning science by doing, ICT, Electronics and Communication or any other field. The development in educational technology supports individualized learning, serve the need of rural and urban education, provide high level of flexibility. Web tools, virtual laboratory and MOOCs

platforms have immensely influenced the current teaching and learning process (Christine Booth, *et al.,* 2016).

The role of technology in higher learning is increasing, as it provide flexible, self paced learning. ICT provide opportunity of collaboration, enhance human thinking and to enhance the educational process. With the increasing use of virtual technologies learners motivation and engagement is incrasing. These technologies provide flexible virtual learning environment and allow a constructivist approach of learning where learner share services like computer desktop, attending videoconferences, drawing on whiteboards, showing presentations, etc. Teaching and learning technologies like virtual lab, can be used to create an exciting, motivating and interactive environment for learners. ICT enabled e-learning platforms not only provide access to quality learning content to the learners across the barriers but also have added value of providing students with immediate feedback. Due to development in ICT, new opportunities are opening up for the youth specially students who are aspiring their carries in Computer and ICT. Hence there is huge challenge for academic institutions and academic governing of developing country like India to plan and establish good Computer and ICT education from elementary level to the higher education and research to create well equipped work force which may meet the demand of future.

Practical are important component of the educational process. In teaching of Computer Science and ICT practical play very important role, but providing proper practical environment is a big challenge. Computer and ICT lab setting need infrastructure, hardware & software and proper maintenance up gradation plan. Setting up a quality Computer and ICT lab is outside the scope of many institutions. A solution to the above problem could be found by the adaptation of Virtual Labs, to- (Ismaila and Ismaila, 2016; Nane Kratzke, 2012)

1. Provide facility of implementing concepts programming of programming, problem solving, network configuration and administration etc. through remote environment.
2. Provide facility of access to different tools and software applications for learning and practice.
3. Provide additional web-resources, video-lectures, animations for exploration and self evaluation.
4. Provide ubiquitous access through a Web browser or mobile device.

In general, Computer Science and ICT are close and interdependent disciplines. Computer Science and ICT are complementary subjects with some overlapping. Generally ICT deals with the aspects of providing and developing software. Computer Science deals mainly with teaching of concepts of software development and design and development of ICT hardware. To study Computer and ICT it is essential to have basic conceptual knowledge of other domains like mathematics and other related subjects such as physics and statistics. Further this paper is organized as follows. In section 2, brief explanation about ICT Education is given. Section 3 explains Computer and ICT education and role of practical labs in it. Section 4 describes virtual laboratory and its advantages. Section 5, presets the proposed model of virtual laboratory for teaching Computer Science and ICT through ODL. Finally section 5 concludes the paper. In this paper words student and learners are interchangeably used.

ICT AND COMPUTER EDUCATION

ICT EDUCATION:
To work with ICT it is essential to have basic knowledge of working of applications and tools being used for solving specific problem. For example if one need to use email service, which is a very basic and useful service, it necessary to have email account. To teach how to create email account and how use it may be one of the good examples of basic ICT education. To use email service Internet is essential, hence teaching about Internet and its services may be considered as part of curriculum of ICT teaching. Similarly to use social networking services like Whatsapp, Facebook one need to have basic knowledge using social network service and basic functionalities being offered by that social service applications. Also understanding about what to do and what not to do is very important in using social networking and Internet services. Similarly working knowledge of general purpose applications including data processing, preparing presentations, playing video,

drawing diagrams etc. are part of basic ICT education. To learn how to identify system specification required for specific applications and installation of hardware and software is also very much part of ICT education. Proper training of ICT may enable the students to use ICT in their learning process of other courses with more creatively and effectively. ICT curricula at school level should be designed in such a way that it not only focuses on simply how to use computers for a set task but also it enable the students to use a range of ICT tools in a relevant way that help them to develop the understanding of ICT domain and practice of the safe use of ICT. ICT education should include the role of ICT in society, including the benefits and challenges. ICT may be used as a tool for social skills development of students by encouraging them to participate in cooperative learning and problem solving using group projects. Indira Gandhi National Open University(IGNOU) offer one Programme 'Certificate in Information Technology' (CIT) which introduce learners about use of computer, programming skill, concepts of computer network, word processing, use of databases and multimedia, creation of web pages and use of ICT in society.

COMPUTER EDUCATION:
Computer Science is one of the well established branches of study. It deals with development and use of the digital systems that are being used in almost all the walk of life. As we observe in our daily life; about workings of Mats, Physics, Chemistry and Biology etc., around us. Therefore schools offer these courses to the students from very beginning to expose and train them in all these subject areas with the help of examples of the activities happening around them. Similarly now use of Computer and ICT are very much part of our daily life happening, hence Computer Science is a discipline, like Moths, Physics, or Social Science. It has a comprehensive body of knowledge, established techniques, and thinking skills, that will last students for lifetime. Also there are good opportunities for carries after having qualifications in Computer Science. As almost all the areas of operations and services including Smart cities, Banking & finance, Automobile industry, e-Governance, e-Education etc. need experts from area of Computers and ICT. Computer Science is one of the intensely creative subjects where students during study learn problem solving skills, design and development of systems, create computer program and test them, also some time share ideas that have never before existed. Also learning about writing a computer program, may give opportunity to school students to develop logical thinking.

Best part of core skill-set of computer science is that it is independent of new technologies and programming techniques, and the principles learnt in computer science will hold true and useful throughout the computer professional life and thereafter. Computer Science education develop a thorough grounding in logic and implementation, and is also being used in study of other scientific fields like computational biology, data analytics, in different domain areas. In Computer Science discipline many core principles are be taught, explained and demonstrated without relying on the use of a specific technology. Some core courses in Computer Science include Programming Principles, Algorithms, Operating System, Networking and Communication, DBMS, Discrete Mathematics, Graph Theory, Modeling & Simulations etc. Computer science is a discipline of study which solves the problems of real life; be it Computerized Banking System, Road Traffic Management System or any other area, by using the underlying basic concepts and principles of various fields of study, application systems are designed and developed. Hence like other discipline of study Computer Science also applied to various domains to solve problem by developing computerized automated systems. Main objective of computer science teaching is to prepare students in such a way that they may learn concepts, tools and technologies so that they may take the challenge of developing software for different domains of problem solving, and also develop capabilities to manage and maintain software in use.

Problem solving and programming depends on critical thinking. Hence critical thinking development for problem solving should start, by teaching students the concept of algorithm in such a way that first they attempt to explore different algorithms to solve the problems, with which they are already familiar with. This will make students confident to express their ideas clearly, without ambiguities, using a precise terminology. Some basic algorithms may be cooking recipes, treatment of patients by doctors, explaining directions for going home from school finding that that who is smallest in height in a class. There may be many more problems of generic nature that can

be explained to the students to develop critical thinking. Also as there may be different solutions/algorithms for same problem, students should be encouraged to explore it. This gives students freedom to explore the different possibilities and engage in creative thinking, which is core of study of computer science. While learning programming at first instance, students first spend a great deal of time in learning the syntax and semantics of the language in which they write their program (algorithms implementation). At this stage, job of language translator and translation process should be demonstrated in lab. Similarly other practical aspects associated with Structured Query Language in DBMS study, circuit design, demonstration of traffic flow in Computer Networking etc. should be demonstrated to students in lab.

ROLE OF COMPUTER LAB IN TEACHING COMPUTER AND ICT

Computer science and ICT is the discipline of study where nothing works if it is not implemented with proper logic and tested properly. Testing verifies that developed application is working as per requirements. Therefore since be beginning (elementary level) computer and ICT should be taught in such a way that students can test the concepts by implementing them directly in labs, also training of basic software for word processing, presentation preparation, data handling, drawing etc. should be more labs oriented. For example if students are explained about computer and its peripheral devices by demonstrating its connectivity and working in lab, it will be more beneficial than explaining in theory class.

Learning by doing is a better way Computer Science and ICT; also it exactly fit with the saying that "one ounce of practice is more than thousand words of theory". In lab the teacher can demonstrate procedures to the students "live" on the computer. For example, how to prepare a word document consisting of a table, filling online forms or how to access the Internet, all these activities may be explained on computer directly. This type of live presentation is not complex, and requires only a little preparation, but is more effective way of teaching and learning. Also students should be demonstrated some existing online systems such as, Online Railway Reservation System, Online Gaming, and some live demo of share market etc. All there demonstrations make students aware about different complex enterprise systems (Hans-Friedrich Vahlensieck, 2005).

To engage students in lab exercises and motivate them for learning some incentive in terms of better grade in examination and good job prospects after getting expertise in subject should be explained. Also during the lab exercise, teacher should move around in the lab and observe their activities, increases their accessibility to students and alert students for possible points of confusion. To encourage collaborative learning, student's actives should be continuously monitored and those students who have completed the assignment should be engaged to help other students in the class. Proper records of all the lab assignments should be maintained and at the end of session it should be returned to individual students (Samuel and Amanda, 2010; Computing at School, 2012).

VIRTUAL LABS

Technically a Virtual Lab is a collection of computing, storage and networking resources, used by educational organizations for educational or research purposes. Utilization of virtual lab varies from a small group of students to a large group of students geographically apart and belonging to different institutions. Virtual labs can be reached through any computer network and are controlled using a Learning Management System (LMS). Students registration, access control and monitoring of progress is done by LMS (Amorim, *et al.,* 2014). If any programme of study is having practical courses as its educational requirements, a virtual lab might be a reasonable option. Virtual Labs (http://vlab.co.in/) is an initiative of Ministry of Human Resource Development (MHRD) Under the National Mission on Education through ICT (NMEICT). This initiative is to enhance University education in rural and urban areas. This Virtual Labs portal provide remote-access to Labs in various subject areas of Science and Engineering including Computer Science & Engineering, Electronics & Communication, Physical Science, Chemical Science, to the students at the undergraduate level, post graduate level as well as to research scholars. These laboratory exercises and learning materials are developed by thirteen participating institutions and free for all.

"Cloud computing provides a great collection of computing resources that can be rapidly and elastically provisioned and released based on users' demand to serve a wide and regularly expanding variety of information processing requirements" (Ismaila W. Oladimeji and Ismaila M. Folashade, 2016). In other words cloud computing proved flexibility, scalability and cost effectiveness as it work on pay for uses model. One of the useful and scalable E-learning applications is virtual labs deployed on cloud computing environment. Cloud computing is being used for educational purpose many leading IT companies such as Microsoft, Google, Amazon, HP, VMware, and IBM, Oracle, Adobe etc. All of these companies who have launched initiatives to support educational institutions with the necessary learning tools and infrastructure including some free initiatives for society. Some of the educational tools in the cloud provided by IT companies are Microsoft Education Cloud with Microsoft Live@edu, Google Education Cloud with Google Apps Education (GAE) and IBM Cloud Academy provides virtual computers with smart analytics system.

School of Computer and Information Sciences of IGNOU offer three courses in the field of computer and information technology through ODL mode. These three courses are Master of 'Computer Applications' (MCA), 'Bachelor of Computer Applications' (BCA) and 'Certificate in Information Technology' (CIT). These courses are offered across India through its Regional Centers and outside India through its overseas study centers. Large numbers of students register in these programmes every year. These three programmes are highly lab intensive. In MCA, there are total 540 hours allocated for actual working on computers for design, implementation and problem solving. In BCA, there are total 510 hours allocated for actual working on computers for implementation and problem solving and practice on applications and tools in lab. In CIT, total 54 hours are allocated for working on computer for learning different software packages, problem solving and programming and web development. Though IGNOU is having well tested and distributed learning content delivery including various alternative including quality learning materials, radio councelling and video lectures. In addition to it, for providing pear learning experience and expert councelling students are allocated to study centers, where they get expert advice, peer group and facility of computer labs to do their lab exercises, provided to then in the lab manuals. To provide consistent, uniform and quality lab to large number of students of MCA, BCA and CIT programmes of IGNOU, spread not only across the India but also to overseas is a challenging task. A better solution to this problem is to provide Virtual Lab facility to the learners, so that they may get flexible, consistent, monitored, barrier free and cost effective environment for doing their lab exercises (Nane Kratzke, 2012).

MODEL FOR TEACHING COMPUTER AND ICT USING VIRTUAL LAB

The problem of proving consistent quality education to remote areas can be addressed by cloud based learning management system integrated with Virtual Labs. Learners can easily access the study materials and simultaneously do lab experiments virtually using Web based environment on their desktop, laptop or smart phones.

Cloud based Virtual Lab provide elasticity, affordability, availability and simplicity. The Virtual Lab model for ODL given in figure 1 is based on the cloud and is extremely scalable. As per need institutions may choose the services from virtual labs is not very high as there is no need to invest into dedicated hardware with a typical three or five year financial commitment for infrastructure. Also it provides flexibility and options to adjust as per significant increase or decrease of students. This model provides many benefits including the following-

1. Resource sharing which improve the utilization.
2. 24x7 access to lab and learning contents.
3. Extantion of the virtual lab services as per r changing needs.
4. Providing platform for peer group discussion and collaboration.
5. Addition of more experiment and contents as per need in no time.
6. Reduction in travel time leads to productivity enhancements

Fig. 1: Virtual Lab Model for ODL Learners
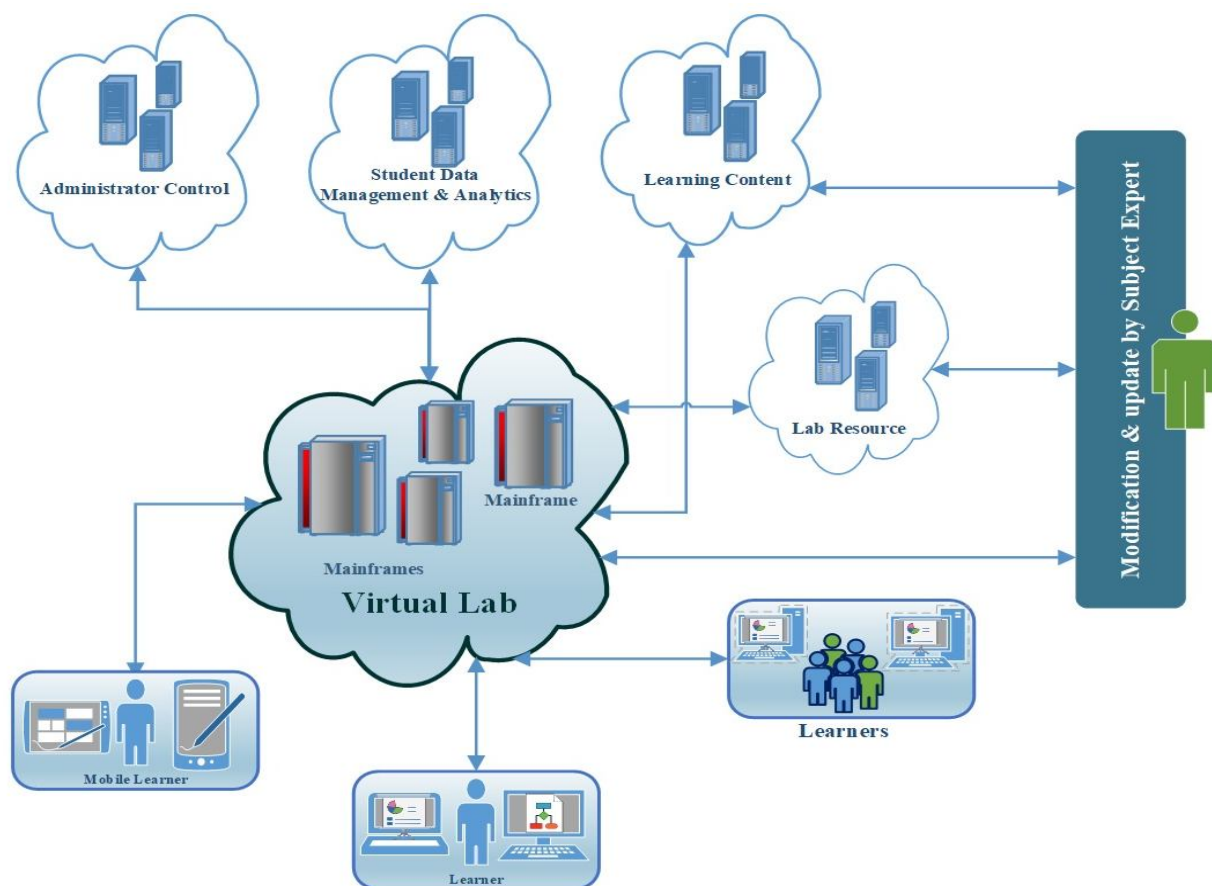
This model is having implementation of Virtual Lab on cloud which is having several components working in collaboration. Institutions planning to develop cloud based LMS integrated with Virtual Lab may choose the type of services they need for example they need hardware and servers for deploying their own developed application or they need software as a service. Also selections of cloud where it will be public cloud, private cloud or hybrid cloud totally depend on the need and scale of the institution. An institution may buy the customized application software from an independent software vendor (ISV) and may deploy it on the cloud. Cloud helps in deploying application faster, with lower upfront costs. Also as easy extantion is possible in cloud based applications, services may be modified or added as per changing needs of the institution. This model of Virtual Lab work around following modules-

ADMINISTRATOR CONTROL:
This module takes care of overall management of system including accounts creation, access control and updates management.

STUDENT DATA MANAGEMENT AND ANALYSIS:
The modules of Virtual Lab manage student's data and do analysis on student's progress and recommend the needed support.

LAB RESOURCES:
This module provide virtual lab to do the exercises and programming environment to write program. Also different tools and software applications are proved for learning and practice.

LEARNING CONTENT MANAGEMENT:
This module provides access to learning contents to the learners.

SUBJECT EXPERT CONTROL:
This module provides services to subject experts to monitor learner's activities, send suggestions and update/modify the lab exercises and learning contents. Using this model organization implementing Virtual Lab can switch at any time to any development environment and choose the services as per need. Virtual lab will be providing features such as learners can do the new experiments, can do modification of predefined experiments, exercise with complex experiments settings. Also mentor/ administrator may do the interpretation of learners engagement and gathered experimental data using learning analysis tool to further guide the learners for better learning and enhance the system as per need. Learners may access multiple external information as guided by the Virtual Lab environment and may collaborate and enhance their educational experience. Practically applications deployed on cloud can be seen as shared computing resources accessible either over the internet or from a datacenter. Finally one of the most important components involved in offering any e-learning is having comprehensive online support related to the virtual lab usage and to the other learning components available. This allows learners to consult additional and external resources as well as explore extensible link list for more information and collaboration.

CONCLUSION

Teaching computer science and ICT through Virtual Labs is the need of hour. To prepare students for future job of ICT market, students should be trained in Computer Science and ICT. This paper explained about objectives of teaching computer and ICT. Also it is explained how teaching through lab demonstration and assignments may be more effective in teaching Computer Science and ICT. As all activities and operations related to different walk of like are shifting toward automation and computerization, it is essential to have computer and ICT facility of quality education from elementary level to University level to encourage interest of students in this field and proved them platform to explore carrier option. To offer lab facility to large number of ODL learners Virtual Labs are good option. Though establishing Virtual Lab facility is an initial hitch but once proper cloud based ICT for teaching learning is explored and offered to the learners, it will be one of the most preferred choice to offer e-learning. In future proposed model should further enhanced and implemented to exploit ICT in education.

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