

# Technology Enabled Learning of Electrical Engineering: A Review

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## ABSTRACT

The role of technology in learning especially e-learning has been high-profile topics in academic and practitioner publications for some years. There are many motivations behind the integration of technology into education by organizations and individuals in the realm of e-learning. These motivations can be exemplified as pedagogical considerations, the drive for innovation, meeting the needs of students and maintaining a competitive profile. In this paper, various technology enabled learning strategies are reviewed and pointed out its drawbacks concerned. Special emphasis has given on e-learning methods that can be adopted in Electrical Engineering domain.

*Keywords: E-Learning, Technology Enabled Learning, On-line Learning & Off-line Learning.*

## Introduction

The term e-learning speaks about electronic learning and is normally used to indicate any use of technology (e.g. computers) to teach. The JISC defines e-learning as learning supported and facilitated through the use of ICT (JISC, 2004). That is to say, the word *electronic* in the term e-learning is considered as ICT in the report of JISC. JISC limits the use of ICT to peculiar hardware and software.

The term “*software*” is used to indicate the use of applications particularly assistive software, virtual learning environments and learning activity management systems, email, discussion boards, video conferencing and the word “*hardware*” to show tools namely computers, interactive whiteboards, digital cameras and mobile phones. Likewise, e-learning is described in the report of the Higher Education Academy as computer technologies to support learning. The word electronic represents computer technologies in the report HEA. So many terms such as e-learning, open, distance, online learning and similar terms are used interchangeably, though they have slight differences. Online learning and offline learning can be interpreted as the synonyms of e-learning.

The role of technology in e-learning is considered as high-profile topic in academic and practitioner publications for the past few years. Information and communications technology (ICT) has important significance for education together with their widespread affect on contemporary society and economies. For example, Steffens (2008) focuses on the use of ICT in the classroom and about the roles of teachers and students. According to Laurillard (2007), ICT creates a common place for the discovery, articulation and dissemination of knowledge and hence affect the knowledge learned and skills evolved within a culture or society. Technology and education are integrated and brought together with the help of this medium.



The ultimate aim in bringing technology and education in sync is to utilize the advantages of technology in learning the knowledge and in developing skills.

## **Evolution of e-Learning in Engineering**

The term e-learning most likely originated during the 1980's, though the origin of the terms e-learning is not certain (Moore, et al., 2010). However, Benson (2002)] stated that online learning is a newer version of distance learning. Like Benson, many authors perceive that there is a relationship between e-learning and distance learning, though they have important differences and similarities. However, Moore at al. (2010) investigated the perceptions of these two terms through a survey and found a point from the feedback that distance learning was perceived as old-fashioned – belonging to a time in the past. Besides, many written texts used the terms online learning, distance learning and e-learning interchangeably. Murphy and Chris Sharman (2006) also noted that the growth of communication technologies has made distance learning easier in recent years and those have also led to the advent of new terms known as e-learning. It is therefore important to date back to the origins of distance learning to understand e-learning much better globally especially from the perspectives of Turkey and the United Kingdom. The term distance learning is defined as the form of study, which is not led by teachers present in the classrooms but supported by tutors at a distance from the students (Sewart, et al., 1983). From this brief description, I interpret that two conditions might exist before distance learning can happen: (i) the separation of the teacher and the learner in terms of geography and time and (ii) the support of the teacher to the student with the help of an organization. Sewart et al. (1983) therefore equated distance learning with correspondence learning due to those two conditions. The early pioneers of distance learning were Isaac Pitman and Caleb Phillips. Some sources credit Isaac Pitman as the early pioneer of distance learning, who started correspondence learning in 1840 in Bath in England and asked his students to copy the short passages of the Bible and return them for grading though the post system. However, Caleb Phillips is also recognized as the teacher of new method of short hand in 1728 in Boston (Holmberg, 2005). However, the methods used by Pitman are considered as much more modern. The history of distance learning is interpreted differently. However, the main feature of those citations might be identified and interpreted in terms of its interactivity, technology and chronology. Many words such as interactive, interactivity and interaction are derived from the word interact to describe people or things that talk to each other, work together or affect each other.

It is therefore easy to find the terms interaction and interactivity to use interchangeably, though they serve at cross-purposes. The word interaction is mainly used to imply an occasion when two or more people or things communicate with or react to each other such as interaction between two languages or interaction between teacher and learner. On the other hand, the word interactivity is described as the involvement of users in the exchange of information with computers and the degree to which this happens. Besides, RoblyerandEkhaml (2000) highlighted that the focus of those words are different: interaction focuses on people's behaviours and interactivity focuses on characteristics of a system. According to these explanations, I interpret the word interactivity here as the degree of interaction between things or people that talk to each other, work together or affect each other.

RoblyerandEkhaml (2000) considered interactivity as one factor that plays a primary role in the achievement and satisfaction of students in distance learning programmes and noted that technologies supporting high interactivity seem necessary to allow person-to-person and person-to-system interaction. However, it should be also noted that interaction refers to action and reaction chain, which can be verbal or non-verbal. From this perspective, we can interpret the evaluation of distance learning in terms of interactivity and categorize into groups. There are many ways to establish interactions between things or people. However, the main methods we used today are generally based on verbal (e.g. oral and written communications) and non-verbal communications (e.g. gesture, body language, posture, tone of voice, facial expressions, touch). For example, RoblyerandEkhaml (2000) found that many students never choose distance learning because it could never provide the qualities of face-to-face course. It seems that the main reason behind the perceptions of such students is that all types of communications are used in traditional learning actively and together this brings high interactivity into the classroom. It is therefore important to evaluate the history of distance learning in terms of interactivity.

#### **Advantages and Disadvantages of Technology Enabled Education (TEE)**

Different benefits claimed for e-learning can be identified. Tangible benefits of e-learning can be listed based on the final report of the Higher Education Academy (HEA), Association for Learning Technology (ALT), the Joint Information Systems Committee (JISC) and the works of authors who actively carry out research in e-learning as follows (Ferrell, et al., 2007), (Mackeogh & Fox, 2009), (Yamamoto & Aydin, 2009):

- **Time Economy:** it gives reduction in time associated with marking and development of subsequent activities. **Cost effective** as it provides significant reduction in delivery cost and e-assessment because automated marking takes seconds rather than hours in addition to immediate savings in printing costs. **Achievement** as it offers increased opportunities in terms of student retention and actively involvement in learning. **Uniformity:** as everyone gets the same standard content; **Easy to track** as it facilitates registration, monitoring of learning progress, testing and record-keeping; **Empowering** as it allows learners to regulate their learning pace; **Interactivity** as students are part of learning by practicing, analysing data and performing task; **Economy** as it saves expenses such as transportation, accommodation, complementary materials and commuting between home and university; **Flexibility** as there is no need for a tutor to be available throughout the entire process; **Productivity** as it can be adjusted and tailored to the needs of organizations and individuals;

However, despite the benefits of e-learning, some researchers such as (Chapnick, 2000) (Anderson, 2002) and (Bean, 2003) propose that e-learning should be implemented very carefully due to its potential drawbacks. Potential drawbacks of e-learning are also claimed by (Pollard & Hillage, 2001) (Bean, 2003) (Trinidad & Pearson, 2004) and (Aydin & Tasci, 2005) as follows:

- **Costly** as conducting e-learning without careful planning most likely ends with cost overruns; **Technology dependent** as it needs access to appropriate hardware and software; **Unsuitability** as it is not suitable for some soft skills development relying

on interpersonal contact and as it require high levels of self-discipline and self-motivation; *Incompatibility* as it sometimes not compatible with other systems and material; *Expensive* as the cost of developing content and providing the essential infrastructure is high; *Dependency* as it still dependent on human support such as management support and the use of the software.

**Implementation of E-Learning:** There are no clear methodologies and ways of thinking to bring the disciplines of technology and education as they mutually challenge each other according to (Laurillard, 2007). In addition, Chartlon et al highlight that technology in education adds another dimension to creating knowledge products captured in learning designs and lesson plans because teachers need to know when, how and what technology to apply, and to understand the impact of taking such a challenge due to the availability of a variety of tools in technology(Chartlon, et al., 2012) .Therefore, it is important to understand what technology offers and what education needs to develop clear methodologies and ways of thinking to bring these two research fields. It is also noted that education has problems and technology has solutions looking for problems(Laurillard, 2008) . For instance, broadband technology is a solution for students at a distance from the university campus because it allows those students to have similar access to resources, multimedia and fast downloads as students using terminals on campus(Mason & Rennie, 2004) .However, it is also argued that the solutions especially new technologies offer are solutions to problems that education does not have(Laurillard, 2008) . It is therefore important to make sure these two-research fields *technology* and *education* fit and this complementarity fuels clear methodologies to bring together technology and education to take advantages of technology in learning the knowledge and in developing skills.

In this regard, it is crucial to analyse the educational problems and use this analysis to identify the solutions from what technology offers because integrating technology in education is not only a technical matter (Rodríguez, et al., 2012). Moreover, it is important to work out the optimal technologies for the educational problems and to consider the educational enterprise from the point of view of teachers and students because they are at the centre of the educational problems. Additionally, it is important to note here that teachers attempting to integrate technology into their teaching also face a variety of challenges in today's classrooms (Cowan, 2008). Such challenges are not only associated with the use of technology but they also related to the identification of many factors such as pedagogical approaches and beliefs, teacher confidence, attitudes, and skills relating to ICT, school ICT infrastructure, supervision and technical support, involvement and leadership of school principals and time spent by teachers on meetings, training, exercises and lesson planning (Rodríguez, et al., 2012). Mor and Winters summarize that the integration of technology into education is a challenge because it addresses many issues ranging from learning theory to software engineering (Mor& Winters, 2007).

## **E-Learning Classification**

### **I. On-line Learning & Off-line Learning**

The term online learning is customarily used as equivalent to e-learning, even though it does not correspond to the whole characteristics of e-learning. The word “online” describes

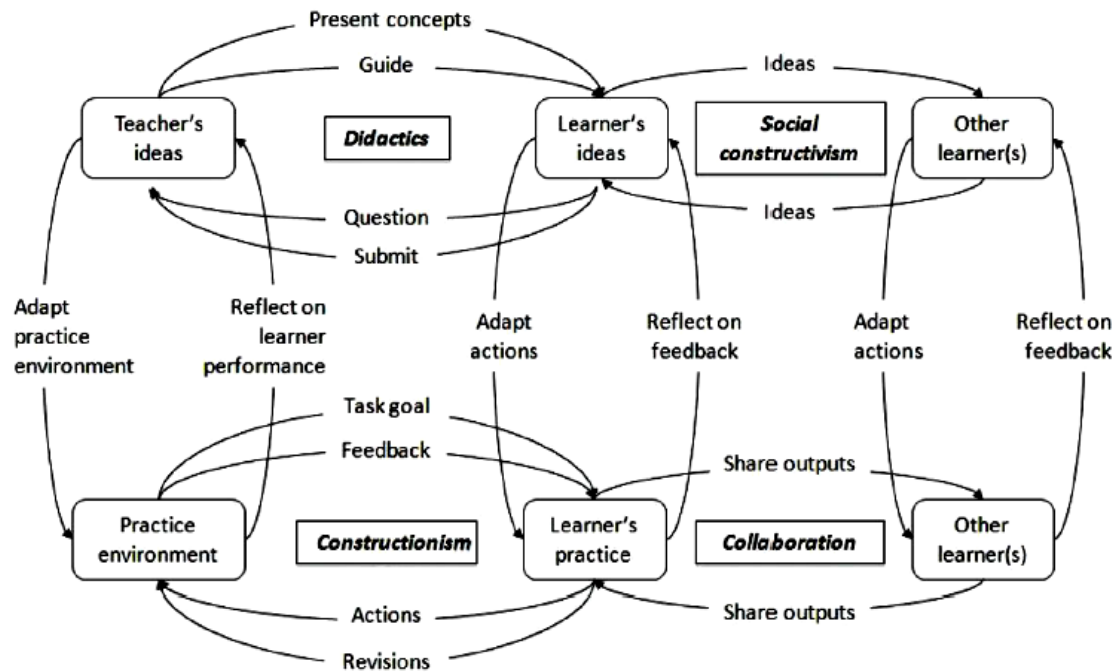
products, services, or knowledge that can be bought or utilised on the Internet. Moore et al. questioned whether e-learning and online learning is the same (Moore, et al., 2010). They found that there are differences between the two terms and those differences also vary from continent to continent in terms of their usage. Oblinger and Oblinger distinguished online learning from e-learning and described online learning as wholly online learning. According to Oblinger et al, some other authors (e.g. (Benson, 2002; Carliner, 2004; Conrad, 2002) described online learning as access to learning experiences via the use of some technologies.

#### **A. Asynchronous & Synchronous e-Learning**

The term asynchronous and synchronous e-learning are also generally used to comprehend some characteristics of e-learning. The word asynchronous is used to portray something that is not happening or executed at the same time or speed – opposite to the word synchronous. Hrastinski (2008) noticed that e-learning mainly entrusted on asynchronous means for teaching and learning but the up-to-date improvements in technology have forced to the growth of synchronous e-learning (Hrastinski, 2008). The term synchronous e-learning illustrates synchronous learning as the one that takes place live and in real-time. However, it varies from synchronous learning such as lectures, product demonstrations and other “knowledge dissemination” activities because synchronous e-learning occurs through electronic means (Hyder, et al., 2007). Furthur, Lado (2008) mentioned that synchronous e-learning, which happens live, can help students to overcome geographical barriers (Lado, 2008). As stated in both Lado (ibid) and Hyder et al. (2007), I interpret the term synchronous e-learning as learning that takes places live through electronic means but it is independent of space. Technologies set for asynchronous e-learning are generally categorized as instant messaging, live webcasting, audio and video conferencing.

#### **Learning Theories**

E-Learning is all about the use of technology to enrich the learning especially with the proper use of the Internet. So learning by means of technology play an important role in producing an effective and adaptable learning circumstance when referring to e-learning. As I mentioned above, terms such as e-learning, online learning and so on are used in reciprocally, though they have noticeable differences. However, the word learning“ is the most relevant factor shared by all of them and common to each of them (Race, 2005). Therefore, it is very essential to understand theories of learning as they are there to direct our approach for providing what learners and teachers require. Theories of learning comprises of the several aspects of the learning process. For example, Diana Laurillard and her colleagues inspected learning theories explicitly to find out the aspects of learning process such as the inter relationship between teacher and learner, and among theory and practice as illustrated in Figure 2. In the groundwork, the teacher is portrayed in dialogue with a learner and every learner in dialogue with other learners. The framework also characterizes the learning process as a series of activities by teachers and learners, cycling within theory and practice, between teacher and each learner and among learners.



**Figure 2:** The Conversational Framework

MellOw, et al.(2011) describe the conversational framework in terms of learning theories: first, a didactic form of teaching and learning appears when a teacher presents ideas and the learner asks questions. The second theory in the framework is the social constructivism that learners need to elucidate about debate and work out ideas. On the other hand, learning by means of collaboration happens when learners work in partnership to summarise the outputs of the practice. However, to actualize constructionism, learners have to use their ideas to accomplish a goal in a real world environment. As stated above, theories of learning imply the several variant aspects of the learning process. Anyhow, MellOw, et al. (2011) pointed out that the education society are well known about learning theories but they does not always put on this knowledge. For instance, the didactic form of teaching and learning is considered as the prevailing pedagogy for engineering education in spite of the large body of education research advocates and other approaches (Mills and F.Treagust., 2003). Along with it, Weller (2004) reports that to pass on teaching approach from one medium to another is not much convincing (Weller, 2004). For instance, there are a number of pedagogical reasons for the ineffectiveness of the standard lecture hall alike an online teaching hall. For these judgements, many educators find themselves as adapting their approach. So, it is very important to adopt learning theories in practice.

### III. The e-Learning Arena of Electrical Engineering Education

Technology enabled learning and teaching scenario in electrical engineering became robust in the last couple of decades through the following means:

1. **Web-based learning and Massive Online Open-Source Courses (MOOC) :** In this scheme of Teaching-Learning Scheme includes online course content, discussion boards, videoconferencing, and live lectures (video streaming) etc. *This scheme* may also provide static pages such as printed course materials.

Classic examples for these types of courses are the MOOCs run by IIT-Bombay through IIT-BombayX platform and MIT. IIT-BombayX platform specialize in Hybrid MOOCs which captures the benefits of flipped classrooms, online lectures, and live interactions with the IITBombay course instructors on various verticals of electrical engineering. The certification is done by IIT-BombayX based on the online assessments and assignments. Post the course; the resources are archived for the learners.

2. **Tutor Scaffoldings:** These are the resources enables the tutor to support them to have a broader view and understanding of the courseware and domain in specific. Alternate and effective perspective of delivering lectures on the domain in general can be adhered from these online repositories.

Examples are TED Talks and IEEE Education Society resources.

3. **Virtual labs (VL):** An platform itself called as VIRTUAL LAB which is an Initiative of Ministry of Human Resource Development (MHRD) and the National Mission on Education through ICT is available for the electrical engineering students and institutions which are facing difficulty in procuring expensive and sophisticated lab equipments for conducting their labs. India's Institutes of Excellence like various IITs and NITs hosts numerous virtual labs extend from Electrical Machines to High Voltage Engineering labs.

VLs provide remote-access to Labs in various disciplines of Science and Engineering. These Virtual Labs would cater to students at the undergraduate level, post graduate level as well as to research scholars. It offers a complete Learning Management System around the Virtual Labs where the students can avail the various tools for learning, including additional web-resources, video-lectures, animated demonstrations and self evaluation and able to share costly equipment and resources, which are otherwise available to limited number of users due to constraints on time and geographical distances. In VLs, modelling the physical phenomenon by a set of equations and carrying out simulations to yield the result of the particular experiment. This can, at-the-best, provide an approximate version of the 'real-world' experiment. Virtual Labs will be made more effective and realistic by providing additional inputs to the students like accompanying audio and video streaming of an actual lab experiment and equipment. Obviously, for the 'touch and feel' part, the students can possibly visit an actual laboratory for a short duration.

### **Conclusion**

In this paper, various e-learning methods adopted in the last couple of decade have been reviewed. Basic classification of technology enabled education in general is discussed along with its advantages and respective challenges. Existing e-learning options in electrical engineering domain is surveyed with special emphasis of teacher scaffoldings. Its evident that from remote resource sharing to adhoc mobile apps keeps the learner group creatively

engaged, at the same time knowledge transfer remains robust. The future probably lies with Virtual Reality Labs and Augmented Reality platforms.

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