



Towards Electronic Technology in ICT Age

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Abstract

In recent decades, Information and Communication Technology (ICT) has advanced and widely spread around the world. ICT and Internet revolution play a major role in the emergence of a new age called ICT Age. Hence, Electronic Technology (E-Technology) is becoming the prominent approach based on ICT such as Electronic Learning (E-Learning), Electronic Training (E-Training), Virtual Lab, etc. E-Technology has some features; it can be used by anyone, anywhere and anytime, and it can reduce geographical barriers. E-Technology is a great trend that influences many fields and areas such as learning, training, military, aviation, medicine, engineering and science. E-Technology is a valuable tool that provides a myriad of opportunities for learning and training processes for individuals and organizations, and can be helpful for some critical cases. It has both constructive and destructive approaches; therefore it should be used with extreme caution.

Keywords: Information and Communication Technology (ICT), Internet, Electronic Technology (E-Technology), Electronic Learning (E-Learning), Electronic Training (E-Training)

1 Introduction

It is noteworthy that Information and Communication Technology (ICT) has widely developed and spread. ICT is considered as a global phenomenon that has turned the world into a small village, managing to eliminate or reduce barriers around world. A considerable overlap of ICT aspects is seen in our life, and we live in an age powered, supported and fueled by ICT, called ICT Age.

ICT approach provides and creates a wider scope of the type of technology. It also estimates the use of various technologies and their impact on society, organizations and individuals [1]. The United Nations Educational, Scientific and Cultural Organization (UNESCO) describes ICT concept as the overlap between information technology and other related technologies, especially communications technology [2]. ICT can be used in several fields, for instance, commerce, education, training, health, military, medicine, engineering, science and defense, in addition to other fields as indicated in Table 1 [3].

Table 1 Fields Related to ICT Usage

▪ Learning and Teaching
▪ Virtual Laboratory
▪ Evaluation
▪ Remedial Teaching
▪ Diagnostic Testing
▪ Psychological Testing
▪ Online Tutoring
▪ Development of Reasoning & Thinking
▪ Instructional Material Development
▪ Assessment

ICT can be defined as follows:

The technologies which contain computers, communication, and information equipment used by individuals or organizations for various functions or tasks.

It is worthy to indicate the wide spread of ICT in daily life through the next figure set by the International Telecommunication Union (ITU). Figure 1, illustrates the developments of many components of ICT from 2001 to 2018 [4].

Furthermore, Internet is considered as the core of ICT becoming more influential and phenomenal. The use of the Internet has spread exponentially by individuals. Figure 2, shows the percentage of Internet users during the period from 2005 - 2019, according to ITU statistics [5].

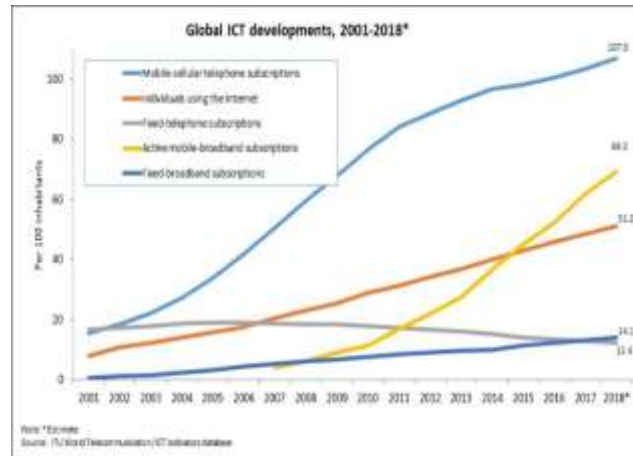


Figure 1 Global ICT Developments - 2001 to 2018[4]

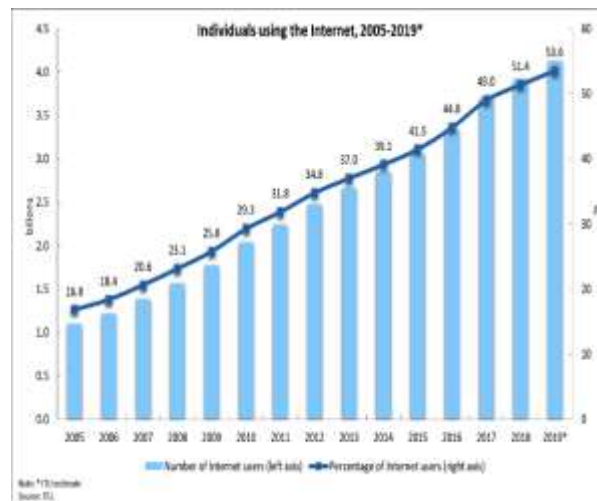


Figure 2 Individuals using Internet, 2005-2019 [5]

Electronic Technology (E-Technology) has been the most popular field over the last decades. It depends on ICT and other related aspects such as computer systems and the Internet. Recently, E-Technology has been considered as a great trend that influences many fields and areas such as military, aviation, medicine and digital space. Particularly, E-Technology is a valuable and useful tool in research area [6]. There are positive and negative approaches of E-Technology. According to ethical issues, users can avoid negative approaches as much as possible. Figure 3, indicates and classifies the most major common positive and negative approaches of E-Technology.

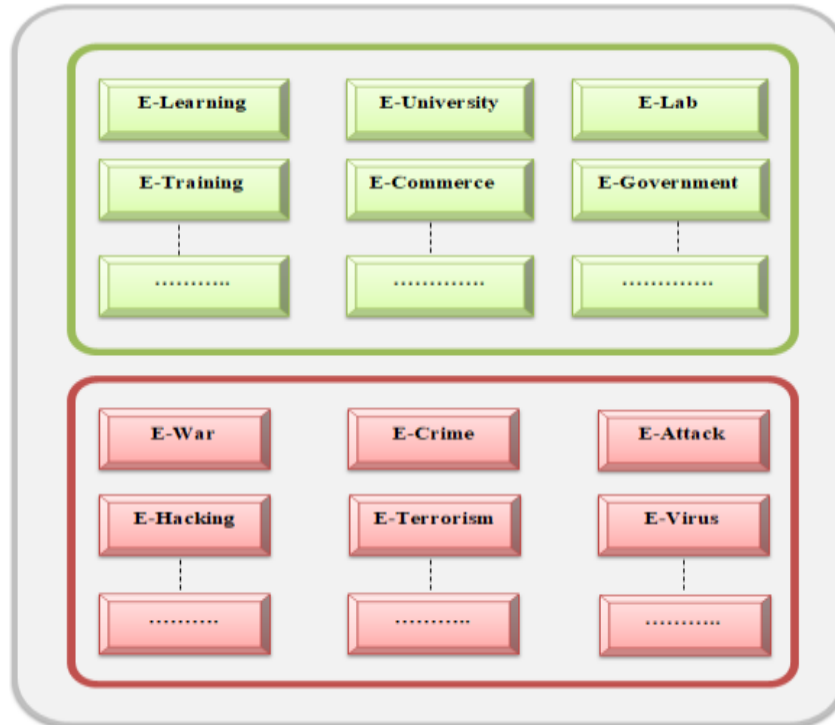


Figure 3 Positive and Negative Approaches of E-Technology

There are many positive approaches of E-Technology such as Electronic Learning (E-Learning), Electronic Training (E-Training), Virtual Lab, etc.

2 Electronic Learning

In the last few decades, Electronic-Learning (E-Learning) has been increasingly expanding as one of the most modern technologies across the globe. It is an effective technology which is related to ICT. E-Learning can be used in several fields such as education, health, military, medicine, nursing, science and engineering. E-Learning is characterized by an extreme productivity and provides an abundant availability of learning opportunities [7],[8]. E-Learning supports people around the world in learning and training processes in both specific instructional programs and general interests [9],[10]. There are some alternative terms for E-Learning, e.g. E-Education - Distant Learning - Online Learning - Online Education and Virtual Learning. Given the importance of E-Learning, several institutions organize conferences in this area. For instance, conferences are organized by the University of Defense in Brno, Czech Republic, in addition to biennial conference which is annually organized in Brno since 2007 and known as

"Distant Learning, Simulation and Communication"[11]. Moreover, there exist some governmental initiatives around the world to embrace E-Learning approach for the development of education, e.g. Kazakhstan 2013 Initiative titled "Information in Kazakhstan 2020", has been supported by the State's presidency and targets transition to a digital society. E-Learning is considered as the major pillar of this initiative [12]. E-Learning can be described as an instruction which can be transmitted by means of computer for fostering the learning process. This concept is determined by three items as mentioned in Figure 4 [13].



Figure 4 Items for E-Learning (What-How-Why)

2.1 E-Learning Concept

There are many definitions and concepts that describe E-Learning. Initially, E-Learning was known as "Internet-based training" then "web-based training". E-Learning is personalized instructions transmitted through intranet or Internet. Furthermore, it is referred to as a virtual classroom, a web-based learning and an online learning [14]. E-Learning is commonly referred to as the use of Internet and technological tools for learning and teaching processes. E-Learning can be described as a diversity of forms of technologies which motivates the process of learning. It is distinguished by the use of educational technology, information and knowledge to connect persons to educational resources or to one another according to the aim of learning (formal or informal) [15]. We can define E-Learning as the use of ICT in the process of learning or training for anyone, anytime and anywhere. There are two main types of E-Learning; Synchronous E-Learning (participants can interact in a simultaneous way) and Asynchronous E-Learning (participants can interact in a non-simultaneous way) [16].

2.2 E-Learning Features and key issues

E-Learning has several features as follows [17]:

- Provides a motive to learn.
- Provides learning and education with more flexibility.
- Decreases travel expenses and time.
- Learners can study when Internet is accessible.
- Learners may have access to educational materials selection according to their level of interest, experiences and knowledge.

According to previous study, there are some key E-Learning issues as follows [18]:

- To support E-Learning purposes, institutions and organizations must create a reliable and sufficient technical infrastructure.
- To include E-Learning effectively in the teaching process, lecturers must re-design their materials and courses.
- To use E-Learning means, educators and learners must have flexible technical skills.

E-Learning can create radical changes in several fields. It has become a pivotal element of the teaching process in universities. It has been also introduced prominently through the instructional trend in addition to the corporate community [19]. E-Learning is an electronic transmission method of learning or training [20].

2.3 Simulation-Based E-Learning

Simulation is a useful technique in many fields due to providing a good quality, decreasing cost and avoiding risks. The use of simulations technique and packages in E-Learning technology brings trainees or the learners close to the real life phenomena and situations. The new demand for the next form of E-Learning is simulation-based E-Learning.

Simulation allows us to reduce risk by letting us determine the right procedures instead of making wrong procedures. Simulation technique can be defined as follows:

Simulation constructs a system similar to any phenomenon in the real world and examines or predicts the change in system performance or behavior and views the results.

It is useful to illustrate an example through E-Learning via simulation such as teaching the Selection Sort Algorithm for students in an effective way. This sort of Algorithm is presented through computer engineering departments. There are two ways of Selection Sort Algorithm; an ascending way and a descending way. Selection Sort Algorithm can be illustrated in Figure 5 as follows (Ascending Method):

(Selection Sort) SELECTION (A, N)
 This algorithm sorts the array A with N elements.
 1. Repeat Steps 2 to 3 for K=1,2,....., N-1
 2. Call MIN (A, K, N, LOC).
 3. [Interchange A [K] and A [LOC].]
 Set TEMP:= A [K], A [K]:=A [LOC] and A [LOC]:=TEMP.
 [End of step 1 loop.]
 4. EXIT.

Figure 5 Selection Sort Algorithm [21]

To describe the action of Selection Sort Algorithm, assume an array A that contains 8 elements as follows:

77, 33, 44, 11, 88, 22, 66, 55

By applying the Selection Sort Algorithm to A, the result can be illustrated in Figure 6.

Pass or step	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
K=1,LOC=4	77	33	44	11	88	22	66	55
K=2,LOC=6	11	33	44	77	88	22	66	55
K=3,LOC=6	11	22	44	77	88	33	66	55
K=4,LOC=6	11	22	33	77	88	44	66	55
K=5,LOC=8	11	22	33	44	88	77	66	55
K=6,LOC=7	11	22	33	44	55	77	66	88
K=7,LOC=7	11	22	33	44	55	66	77	88
Sorted:	11	22	33	44	55	66	77	88

Figure 6 An example of Applying Selection Sort Algorithm [21]

First step, get the smallest element in the list and replace it with the first position. Second step, get the second smallest element in the list and replace it with the second position, and so on [21]. Figure 7, illustrates Graphical User Interface (GUI) of Selection Sort Algorithm, which gives an easy way to understand the required content fluently [22].

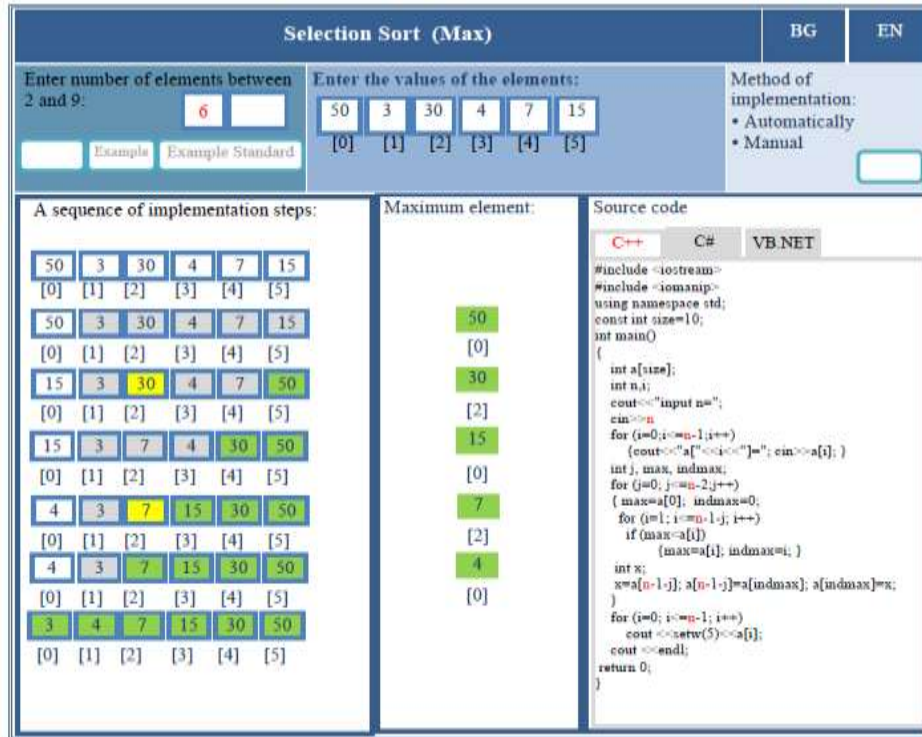


Figure 7 GUI of Selection Sort Algorithm [22]

A previous study [23] presents several concepts such as E-Learning, Blended Learning, Web-based Learning and Internet-based Learning. In addition, the study presents the use of Blended Learning for algorithm and programming course. Moreover, from 2011 onwards, Blended Learning method has been combined in the education process of Computer Engineering study at Suleyman Demirel University -Turkey. To fulfill this purpose, there exists a studio in the department which involves synchronous and asynchronous learning as mentioned in Figure 8.



Figure 8 Studio Environment [23]

3 Electronic Training

Usually, E-Training is like E-Learning in the context, i.e. the ways of transmission, delivery and technological means. Development in computer systems and ICT has led to the appearance of Electronic-Training (E-Training), which is a form of E-Learning used in many fields such as organizations and corporate E-Learning (or E-Training). Web-based training and video conferences are the major forms of E-Training. Figure 9, shows and illustrates training from E-Learning perspective [24].

It is necessary to describe Training and E-Training concept as follows:

- Training is an activity that aims to enhance the behavior and performance of persons. The purpose of the training process often supports the need to increase productivity, as well as to motivate, encourage and inspire persons [25].

- E-Training is an acquisition of knowledge, an increase in performance and a development of skills through using digital technologies.
- E-Training can be used anytime and anywhere, and is characterized by the user interaction, reduced cost, low risk, facilities and convenience.
- E-Training can be described as the use of technology to enable trainees to acquire certain skills and knowledge from a trainer via electronic means [26].
- According to previous study [27], E-Training refers to the use of electronic means to present training for organizations and institutions, which comprises the following items:
 - Learning via CD-ROM in workplace.
 - Self-education through intranet.
 - Live training presented by trainers via through Webcast and past recorded courses.

E-Training is considered as a powerful mechanism in eliminating geographical barriers factor between the trainer and the trainee, in addition to time factor and efforts factor. Person can be trained anytime and anywhere without any obstacles. E-Training can contribute in the employee training, developing skills and human resources fields. It is considered as a powerful tool for drawing and developing the future strategy. E-Training styles can be summarized in the next Figure 10.

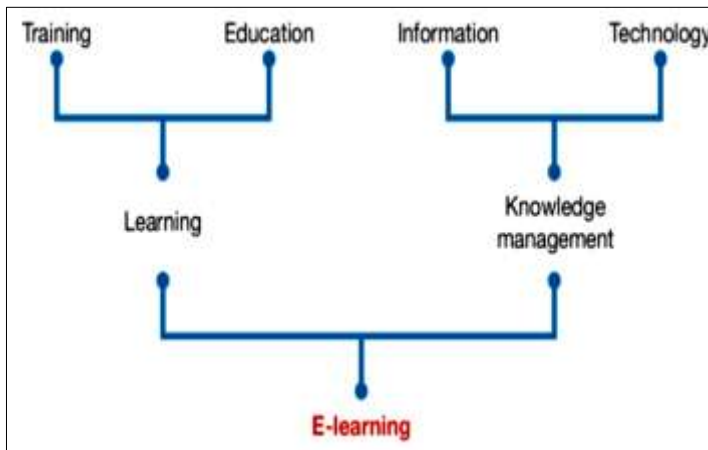


Figure 9 Overview of domains for thought and practice involved in E-learning [24]

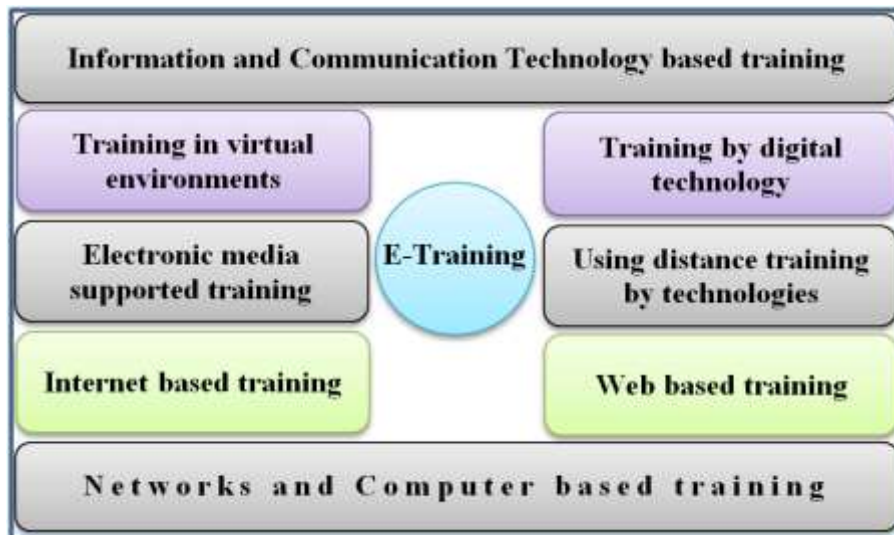


Figure 10 E-Training Styles [27]

E-Training is vital in several fields; medical, nursing, engineering and dangerous experiments.

3.1 E-Learning Vs E-Training

It is necessary to distinguish E-Learning from E-Training. Table (2) indicates the differences between these terms based on some criteria [24], [26], [27], [28], [29], [30].

Table 2 E-Learning Vs E-Training

Criteria	E-Learning	E-Training
Definition	It deals with any type of Learning materials via digital means	It deals with the domain inside an organization
Outcome	Learner have activities in in a structured process	According to the needs of organization
Time	Long period	Short period
Target user	Adults	Members of the corporate
Paradigm	-self-development - Web browsing	-Programmed -Instructional
Measurement	The outcomes of learning.	Use / cost/ reduction.

3.2 E-Learning and E-Training in Engineering Education and Training Fields

With great technological advances, E-Learning and E-Training are becoming more attractive for both flexible engineering education and training fields (For further reading on this topic, see Appendix A which provides a glimpse into varied studies and publications on E-Learning, E-Training and related issues in the engineering field).

4 Recommendation and Vision

Traditional education can be affected by some factors. These factors can be summarized in Figure 11. In addition to spreading of diseases and epidemics.

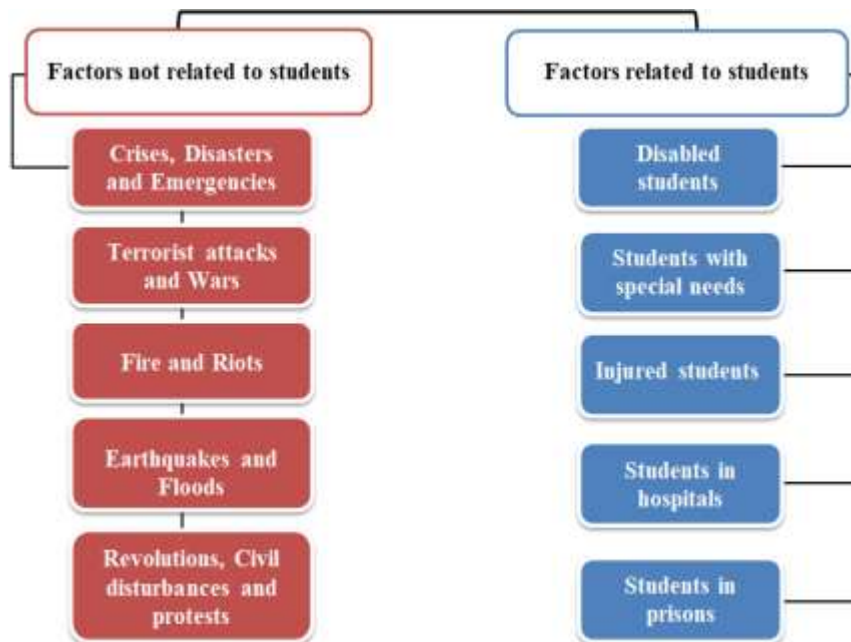


Figure 11 Some Factors Affecting the Traditional Education Sector

As mentioned above, some factors can cause suspension of the study process. There are several examples for the suspension of the study process as follows:

- The study suspension at various Sudanese instructional institutions due to critical and hot events in the Sudan.
- The study suspension at instructional institutions in Sinai, Egypt, due to the military campaign against terrorist attacks.

Prominently, E-Technology such E-Learning and E-Training can enrich the learning process and provide extraordinary opportunities for learners due to the great influence of E-Technology and ICT development sector. It also facilitates active learning/training. By ICT and E-Technology, it is possible for students to learn anytime in any part of the world, especially for students with special conditions as mentioned above in Figure 11. The key trends of E-Learning and E-Training can be summarized in a slogan as mentioned in Figure 12.



Figure 12 Key Trends of E-Learning and E-Training

E-Learning and E-Training include the following characteristics:

- Attractive and interactive methods
- Cost-effective
- Optimum use of ICT
- Lower consumption of resources
- Avoiding real hazardous experiment
- Access flexibility
- Available materials
- Timely content

Furthermore, Top ten merits of E-Learning and E-Training can be shown in Figure 13.

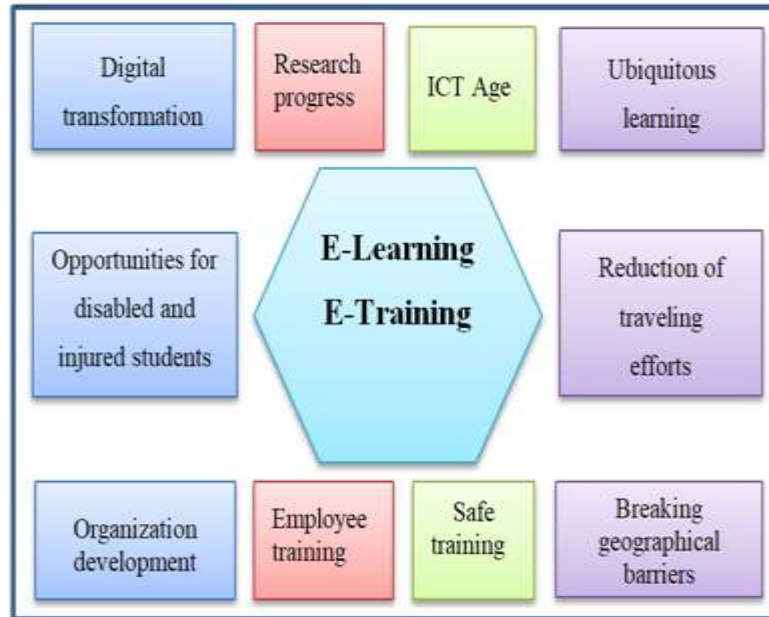


Figure 13 Top Ten Features Of E-Learning And E-Training

5 Conclusion

With the technological revolution, everything around us holds the signature and stamp of ICT. ICT has countless advantages and is penetrating into several fields; medical, engineering, education process, etc. For everyone, technological life can be invested in learning/training trends. E-Learning and E-Training as a positive E-Technology are the major useful technologies of the ICT age. E-Learning and E-Training made the learning process more motivational and attractive. Furthermore, E-Technology can provide lifelong learning/training and can enable persons to continue their learning without conflicts with family or work affairs. It is also considered as a vital weapon in some critical issues, including those related to persons with special needs. Learning is a crucial trend for everyone, thus it is important to increase its availability and convenience for everyone. The approach of distance learning in engineering education has increased in recent years. Finally, the positive and negative approaches of E-Technology should be borne in mind.

Appendix A

The glimpse of varied studies and publications for E-Learning, E-Training and related issues in engineering field can be presented as follows:

No.	Title
1	Integrating digital video resources in teaching E-learning engineering courses
2	Handbook of Research on Applied E-Learning in Engineering and Architecture Education
3	The advancement in using remote laboratories in electrical engineering education: a review
4	Quality enhancement in e-learning activities: improvements by mean of a newly engineered e-learning survey
5	Engineering education island: Teaching engineering in virtual worlds
6	Using Web-based laboratories for control engineering education
7	The Influence of New Tools in Virtual Learning Environments on the Teaching and Learning Process in Chemical Engineering
8	VIEW – A Virtual Interactive Web-based Learning Environment for Engineering
9	An assessment of distance learning laboratory objectives for control engineering education
10	A Remote PLC system for e-Learning
11	Online Engineering Education: A Comprehensive Review
12	The development of a remote laboratory for internet-based engineering education
13	New features for e-learning in higher education for civil engineering
14	A modular virtual reality system for engineering laboratory education
15	Web-based Support for the Instructional Engineering of E-learning Systems
16	Multiplatform virtual laboratory for engineering education
17	The virtual laboratories case study in traditional teaching and e-learning for engineering sciences
18	E-Learning in Civil Engineering: The experience applied to a lecture course in Structural Concrete
19	A Web-Based Tool for Control Engineering Teaching
20	Smart engineering education: The ontology of Internet-of-Things applications
21	E Learning in Engineering Education: Design of a Collaborative Advanced Remote Access Laboratory
22	Towards a better deployment of remote laboratories in undergraduate engineering education
23	Implementation of e-learning platform for electrical engineering
24	Materials science virtual laboratory as an example of the computer aid in materials engineering
25	Continuing engineering education through distance learning
26	PLM education in production design and engineering by e-Learning
27	E-laboratory design and implementation for enhanced science, technology and engineering education
28	Instructional use of engineering visualization: Interaction design in e-learning for civil engineering
29	E-collaborative remote engineering labs
30	Metrics for effectiveness of e-learning objects in software engineering education
31	Engineering e-learning surveys: a new approach
32	Towards the loose coupling between LMS and Remote Laboratories in Online Engineering Education
33	Design engineering educational framework using share fast: a semantic web-based e-learning system
34	e-Learning development in medical physics and engineering
35	Benefit of e-learning teaching C-programming and software engineering in a very large mechanical engineering beginners class
36	Engineering Education through eLearning technology in Spain
37	New methodologies in teaching e-structural mechanics using WWW
38	Suitability and implementation of a WebLab in engineering
39	Engineering education e-assessment with Matlab; Case study in electronic design
40	A practice oriented approach to intelligent computing assisted distance education for engineering
41	A configurable e-learning system for industrial engineering
42	Virtual laboratories for education in science, technology, and engineering: A review
43	Designing a pedagogical model for web engineering education: An evolutionary perspective
44	Electrical engineering teaching and distance learning using a desktop virtual reality system
45	E-learning opportunities for electric power engineers
46	Developing Tele-Operated Laboratories for Manufacturing Engineering Education
47	Applications of e-Learning in engineering education: A case study
48	E-training in mechatronics using innovative remote laboratory
49	An efficient and effective approach to developing engineering E-training courses
50	Integration of an e-learning Platform and a Remote Laboratory for the Experimental Training at Distance in Engineering Education

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