Engineering Education in the 21st Century: Towards a New Educational Paradigm

L'Ingénierie du XXIe Siècle : Vers un Nouveaux Paradigme Educatif

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Abstract

Today, various mobile technologies have profoundly affected many aspects of human life including our way of living, our habits, and the way we work and think, etc. With advances in communication technologies and electronic devices, learners now are capable of accessing and managing information from their smart phones or other technological gadgets. In fact, educational systems have already started implementing ICT into their curriculum and pedagogy responding to the pressures of the digital age and thus, preparing the citizens for the information society. In addition to guaranteeing efficient learning and engaging learners in constructing knowledge, technology offers further chances for success. Besides, by implementing more instructional high-tech tools such as online courses, Interactive White Boards, digital libraries, etc. this may revolutionize the engineering practices, and increase the whole learning experience for the learners of the 21st century. In this regard, this research study investigates the issue of teaching and learning engineering education in the Information age shedding the light on the modern learning practices resulting from the ongoing growth process of information technologies.

Keywords: Engineering Education; E-learning; Information Technology; New Paradigm.

Résumé

Aujourd'hui, diverses technologies mobiles ont profondément affecté de nombreux aspects de la vie humaine, y compris notre mode de vie, nos habitudes, notre façon de travailler et de penser, etc. Avec le progrès de la technologie, les apprenants sont maintenant capables d'accéder à l'information et de la gérer à partir de leur téléphone mobile ou d'autres gadgets technologiques. En fait, les systèmes éducatifs ont déjà commencé à intégrer les TIC dans leurs programmes pour répondre aux pressions de l'ère numérique et ainsi préparer les citoyens à la transformation digitale. En plus de garantir un apprentissage efficace et de faire participer les apprenants à la construction des connaissances, la technologie offre de nouvelles chances de réussite. En outre, en mettant en œuvre des outils de haute technologie plus instructifs tels que des cours en ligne, des tableaux blancs interactifs, des bibliothèques numériques, etc. cela peut révolutionner les pratiques d'ingénierie, et augmenter toute l'expérience d'apprentissage pour les apprenants du 21ème siècle. À cet égard, cette étude examine la question de la formation d'ingénieurs à l'ère du numérique.

Mots clés: Ingénierie; E-learning; l'Ere Numérique; New Educational Paradigm.

Introduction

Information and Communication Technology (ICT) has fundamentally affected a significant number of aspects of our lives, including social relations, economy, education, etc. (Grazello, & Kuhn, 2016). It has greatly influenced the education system in all its forms. In this regard, Chandrakar & Biswal (2006) assume that in the domain of education various types of information and communication media are used to impart education; they proclaim that "radio, TV, tape recorder, teleconference, fax, telephone, and computer with internet have changed our teaching learning modes" (p. 42). The implementation of ICT and particularly e-learning has become an inevitable component of contemporary education that is trying hard to cope with the new Information age.

Today, engineering and technology are seen as "the knowledge to manipulate nature to produce products...energy, and services; and the understanding of the manipulation process that seeks to satisfy human social and economic needs and aspirations" (Dhillon, 2002, p.1). Thus, to combine both elements in higher engineering education institutions would be of great benefit to the interests of education and to society as a whole. The main reason behind the integration of e-learning into education is that it encompasses most of the effective features of the other educational technologies. "It opens life-long learning to people...facilitates dynamic interaction among instructor and learners. In the ultimate, learners will be able to access to learning opportunity anywhere anytime beyond place and time" (Iskander, 2008, p. 526).

1. Engineering Pedagogy in Higher Education: From Old To New Paradigms

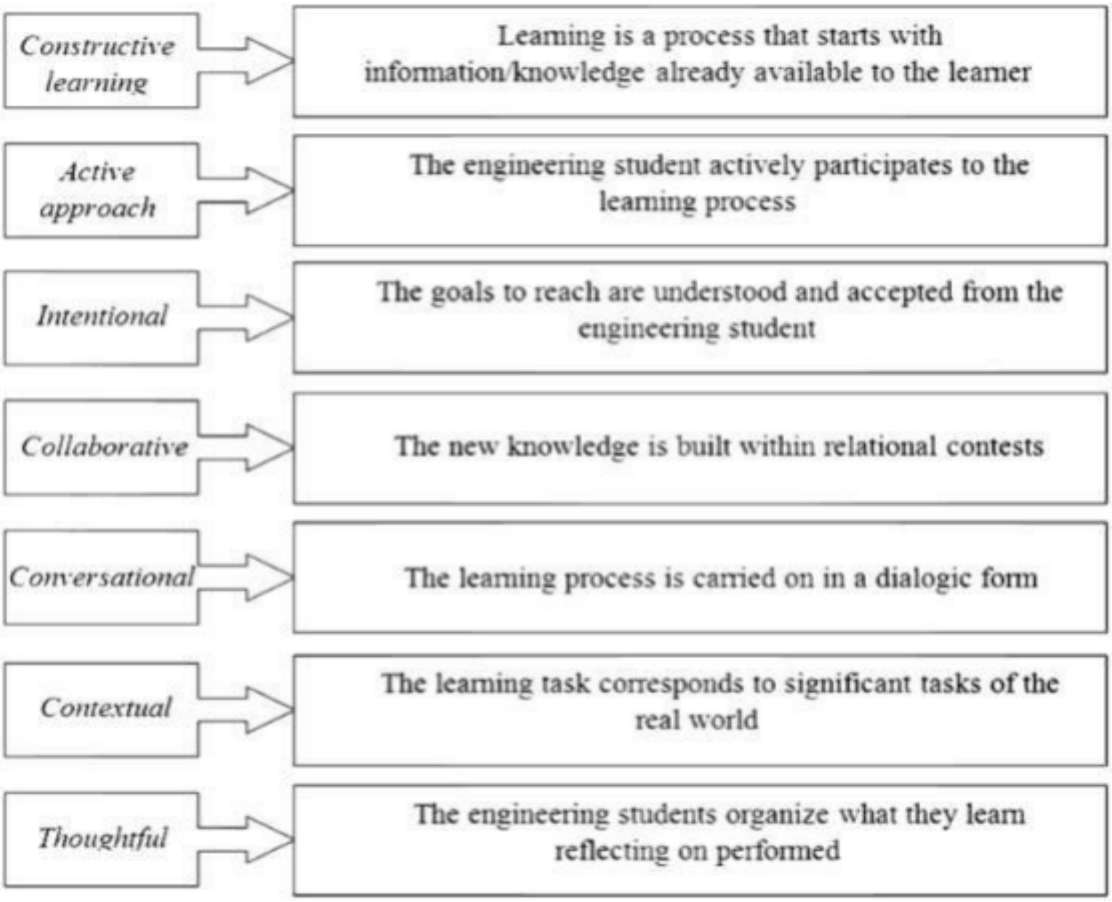
Engineering is associated with knowing and dominating the materials and powers of nature for the sake of mankind. Thus, engineers examine and develop problematic system operations either by adjusting material that is already available to new requirements or incorporating and managing new support systems (Moeller & Sitzmann, 2012). Accordingly, engineering learners need to study the basics and certain current issues of various engineering fields including software engineering, chemical engineering, civil engineering, energy engineering, and industrial engineering that are provided in available conventional engineering and computer engineering curricula. Nonetheless, in the ever-changing world of technology, the future of higher education depends heavily on innovation, highly qualified skills, and creative minds of engineering practitioners. This requires a new set of skills and competences used to teach the engineering labor force of the modern age, particularly, how to promote improved learning opportunities in engineering curricula. To guarantee that engineering practitioners will fulfill these challenges, it is necessary to extend the methods employed in teaching engineers (Chang et al., 2011, as cited in Moeller & Sitzmann, 2012). Jeschk et al. (2005) claim:

> Providing effective, efficient education and training in the engineering domains, online learning, better known as e-learning, has become a state-of-the art approach to ensuring that engineering students understand the complexity of technological innovations at the level of detail that is required for Research and Development (R&D) issues. (As cited in Moeller & Sitzmann, 2012, p. 196)

Conventional instruction for engineers has changed towards modern learning practices as a result of the ongoing growth process of new information technologies. The constant evolution in technology allows the achievement of a further distributed structure of information transmission. Thus, to realize these standards, new teaching methods and techniques are required in addition to a vast array of resources: professionals should be capable of imparting and distributing engineering tools, adjusting and reviewing them to meet the individual requirements. However, electronic learning in engineering education still encounters many hindrances that impede an identical growth rate. For efficient and successful learning in engineering, science and technology, engineering education needs both theoretical and empirical approaches. Thus, to realize how theoretical information can relate to real world issues, empirical practices are indispensable (Noroozi, Valizadeh, & Sorial, 2010). Moreover, engineering software is always quite costly and cannot be reached by all students. Even though other inexpensive options that use free programs have been effectively established and examined, hands-on laboratories that promote engineering education remain hard to be established online (Magoha & Andrew, 2004 as cited in Noroozi, 2010).

The information technology revolution has been considerably altering the learning-teaching experience of engineering education. ICTs are appropriately considered as instruments that are fundamentally altering the educational process. "Universities, institutions, and industries are investing increasing resources to advance researches for providing better and more effective learning solutions" (Campanella et al., 2007, as cited in Haghi &Noroozi, 2016). One of the primary challenges for teaching engineering education is that it emphasizes learner's centeredness and autonomous learning for an effective learning process. The following figure presents the most essential features for engineering instruction:

Figure N°1: The Most Essential Features for Engineering Instruction



Source: Adopted from (Haghi & Noroozi 2016, p. 3)

The major goal of learning engineering education is to achieve three essential learning objectives (Haghi & Noroozi, 2016):

- To teach the engineering learners to be in charge of their own learning and to be able to direct processes to fulfill goals and to realize their learning requirements.
- To support and enhance significant learning settings and experiences, allowing the engineering learners to acquire knowledge and construct information through diverse learning methods and techniques; and
- To design appropriate educational materials and learning activities which serve the acquisition of knowledge.

In these modern times, the implementation of ICTs has enhanced teaching and learning, particularly when conjoined with student-centered teaching approach or convenient education that promotes various modes of interaction between instructor and learner (Danaher, Gururajan, & Hafeez-Baig, 2008). The table below presents comparisons between e-learning and traditional engineering instructional methods:

Table N°1: Difference between E-Learning and Traditional Engineering Instruction.

E-Learning	Traditional engineering learning mthods
It can relies on learners' and it is self-motivation	Lecturer always plays a leading role in motivating and directing the engineering students
Assessment of examinations conduced at learners' place	Assessment and examina-tions time does not depend on learners
Greater achievement is ex-pected in number of students going through engineering courses	Learner restricted to those at-tending university or college
Innovative methods required to reach practical assignments and experiments	Laboratories readily available for practical assignments and experiments
Duration of course normally decided by the engineering student	College of engineering has calendars and set durations for courses

Source: Adopted from (Noroozi, Valizadeh, & Sorial, 2010, p. 9)

E-learning for engineering learners, in all its glory, is the type of instruction that supplements conventional face-to-face teaching and learning activities, and provides a more efficient experience to the student. E-learning represents learning through the application of electronic media and devices, involving the transfer of content via Internet/intranet/audio or video tape, satellite broadcast, interactive TV, or CD-ROM (Sommer, Bach, Richert, &Jeschke, 2014).

Apparently, e-learning for engineers is the integration of technology to promote active learning in the educational process. Basically, it is about placing the student at the center of his/her own learning by providing them with adequate materials and tools. The engineering e-learners are free to direct themselves and take responsibility of their own learning in a way that matches their personal needs. E-learners are able to acquire and build information and skills in a setting that has been adjusted to meet their expectations. Moreover, “the use of the Web as an educational delivery medium (e-learning) provides engineering students with the opportunity to develop an additional set of communication, technical, teamwork, and interpersonal skills that mirror the business environment in which they will work” (Noroozi, Valizadeh, & Sorial, 2010, p. 8).

Nonetheless, engineering learners, as opposed to the idea that they can be viewed as "digital natives", do not all have the same positive reaction to the e-learning experience; certain students prefer on-campus classes. Engineering learners may respond separately to the e-learning setting, based on their skill and perception. Sheard and Lynch's (2003, as cited in Inoue, 2007) declare:

> Study on learner diversity has indicated that different students experience and react to an online environment in different ways, depending on their previous experience, and no one format is going to meet the needs of all students. Therefore, constant challenges for online learning are student's familiarity with the learning environment and their skills and confidence with the Internet and IT. (p.125)

In fact, engineering education needs to address today's challenges. It is clear that every learner has various learning styles and paces; therefore, the learning content should be developed to meet the needs of different audiences, so that learners can choose adequate activities according to their privileged learning styles (Ally & Samaka, 2016). The following table presents the characteristics of old and new paradigms of engineering education:

Table N°2: Characteristics of Old and New Paradigms of Engineering Higher Education.

Engineering Education (Characteristics)	Old Paradigms	New Paradigms
The Curriculum	Focused on scientific and technical courses as the core of an engineering education	Not only focused on scientific and technical courses but include new curriculum that must reflect a broad range of concerns.
The Ability and Skills	Technical knowledge and skills	-Technical knowledge and skills -Communication skills -Teamwork/teambuilding
Pedagogical Style	Classroom based pedagogy-lecture-dominated system	Active learning approaches that engage problem-solving skills and team building.
Lifelong Learning	Less awareness on lifelong learning	Aware on the importance of lifelong learning and concerns more on the knowledge of how to learn.
New Technologies	From microscopic level of info-bio-nano	To the macroscopic level of global systems
A Broader Concern	Focus primarily on educating students for the engineering profession	Educating not simply profesional engineers but a new breed of graduates with an engineering-based, liberal education.

Source: Adopted from (Singh, 2019, p.29)

2. Problem-Based Learning in Engineering Education: A New Approach

Over the last few years, research has been carried out in many countries to identify the technical and personal skills central to today's engineers. This research has revealed some general concerns. Recent engineering graduates must possess team building skills as well as good communication competencies, but they lack such skills. They must possess a wider vision of the challenges that continue to face their occupation, but yet they don't. Eventually, young graduate engineers possess in general a basic theoretical knowledge, but they have difficulty in applying it to problems of practice. Accordingly, this emphasizes that teaching engineering education should involve strategies and approaches that offer many chances to learners so as to promote the improvement of such skills (Wang, Li, Fu, Liu, & Jiang, 2016). In doing so, the following criteria should be taken into consideration (Mills & Treagusr, 2003):

- Engineering educational programs are more concerned with science and technical knowledge without giving enough use of these issues or linking them to engineering practices. Curriculum is content driven.
- Existing programs do not ensure enough engineering design practices and processes to learners.
- Today's graduates still lack adequate communication skills and the ability to work in groups and collaborate with others. Therefore, new approaches to teaching engineering education should be incorporated to help students improve such important skills. • The current instructional strategies used in engineering education are old-fashioned and have to be more learner-centered.

The solutions mainly suggested to address most of these problems require radical redesign of the education program in engineering education. Therefore, Problem-based Learning (PBL) has been introduced to several engineering programs to help learners develop the necessary skills and competences. According to Graff et al., (2007) PBL is "an instructional method where students 'learn to learn', working cooperatively in groups to seek solutions to real world problems" (p.57). It is a new student-driven instructional approach that prompts learners to think critically and analytically. Within this context, learners acquire skills in "self-directed learning, critical thinking, self-evaluation, interpersonal communication" and the skills to collect, obtain, and utilize knowledge (Bentley, 2004). This strategy focuses on a concrete problem-solving process that a small group of students takes part in so as to find a solution. Students thus, become active participants in the learning process; "students formulate and pursue their own learning objectives by searching a situation, developing appropriate questions, and producing their own solution to a problem" (Maxwell, Mergendoller, & Bellisimo, 2005, as cited in Wurdinger, 2012, p.45).

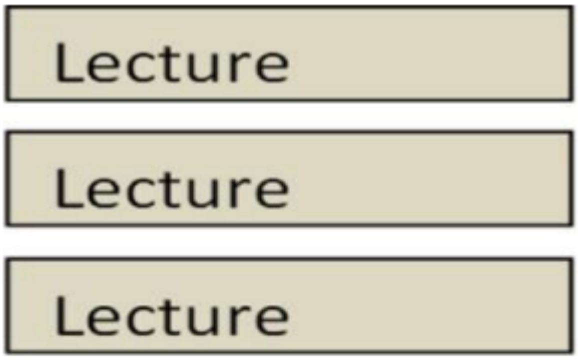
PBL identifies the students' existing knowledge and promotes the students to recognize their own learning processes. Conventional instruction methods that aim to overburden learners with content do not help them in acquiring the skills required in real situations. Without a thorough comprehension of the problem and practice of a specific case, learners will memorize information for just a short period of time, and then information fades quickly; therefore the students are left with an empty or impractical education. Storing information does not help students in addressing the complex issues encountered in engineering practice. Learners have to know how to connect previously learned ideas and notions with new information so as to make the right choices needed for addressing a set of problems they may face in real situations (Bentley, 2004).

In Problem-Based Learning, instructors are no longer at the center of the learning experience. Their role has changed from one of knowledge providers to facilitators who guide students in the process of learning. The instructor is in charge of setting out the objectives of the meetings by determining what is to be fulfilled and how the process operates. According to Hadgraft (1997), the instructor's roles in PBL is of "providing students with adequate initial learning resources; providing a structured learning experience for those students who need it…keeping students jobs on-track; helping to solve technical problems if necessary, and assessing students work" (as cited in Heywood 2005, p. 238). The implementation of PBL in engineering programs requires a shift from teacher-centered to learner-centered instruction and therefore necessitates a fundamental shift in the way learners acquire knowledge and the role that faculty members play in simplifying learning. Krishnan (2012) claims:

> Lifelong competencies engendered by problem-based approaches to learning include the ability to adapt and participate in change, deal with problems and make reasoned decisions in unfamiliar situations, reason critically and creatively, adopt a more universal or holistic approach, practice empathy, and appreciate others' perspectives, collaborate productively in groups or teams, identify personal strengths and weaknesses, undertake appropriate remediation such as self-directed learning and meta-cognitive reflection. (p.26)

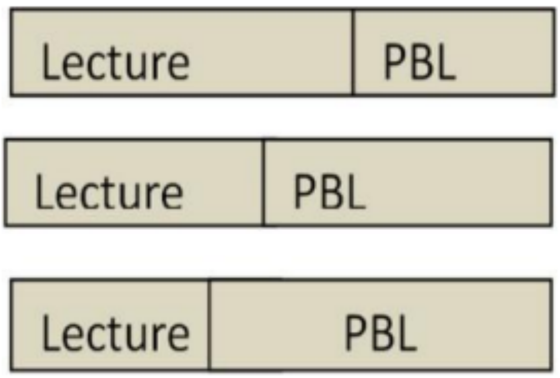
Unlike the conventional approach to designing engineering curricula (see figure 2) that merely depends on a single discipline and in which the teacher is the only source of knowledge, problem-based learning (see figure 3) is an innovative teaching approach that consists of a lecture unit succeeded by a PBL unit, focusing on applying information learned in the course to a real problem situation (Li, 2013).

Figure N°2: “Conventional Curriculum Model”



Source: Adopted from (Li, 2013, p. 27)

Figure N°3: “PBL Curriculum Model”



Source: Adopted from (Li, 2013, p. 28)

3. Laboratory Instruction in Engineering Education

The primary purpose of engineering education is to prepare learners for engineering practices, and especially to handle the great sources of power in nature. Therefore, from the earliest stages of engineering education, pedagogical laboratories have been a fundamental component of its programs. In fact, engineering education relies heavily on laboratories since it is a practical discipline (Handur, Naragund, & Kalwad, 2014). Apparently, “All engineering programs must demonstrate that their graduates have the ability to design and conduct experiments, as well as to analyze and interpret data, design a system, component, or process to meet desired needs; and use the techniques, skills, and modern engineering tools necessary for engineering practice" (ABET engineering criteria, as cited in Anis, 2011, p.45). According to Alam, Hadgraft & Subic (2014), the primary goals of a laboratory practice are, "the cognitive learning (integration of theory with practice), inquisitive learning (hypothesis development, design of experiment and methodology, and evaluation of data, results and findings), vocational learning (awareness of current practice and inculcation of professional ethics), and communication learning (communication, presentation, report writing and team work skills)" (p. 290).

Hands-on laboratories increase a learner's ability to effectively link theoretical understanding with concrete practical activity. The conventional hands-on laboratory practices require physical existence of faculty members, physical facilities and materials that grant learners an approximation of the real world experiences. By participating in laboratory experiments and using the material, the learners are engaged in observing dynamic phenomena, testing hypotheses, and learning from their mistakes (Razali & Trevelyan, 2012). Presently, the educational focus in engineering education has changed towards theoretical instruction 62 employing ICT tools. Technology advances have permitted the creation of new online laboratories: web-based virtual labs and remote labs. The virtual labs or sometimes called web-based simulators are characterized by the implementation of simulated experiments and models to mimic the traditional physical lab environment (Kehind, Chen, Ayodele, & Akinwale, 2011). The function of virtual laboratories is to practice experiments that would involve sophisticated and pricey equipment. Moreover, learners have the right to repeat an experiment several times, providing them with the chance to understand how modified variables and criteria affect the result. Besides, one of the most significant traits of virtual labs is allowing learners to learn from mistakes without damaging the physical material. Remote labs permit remote access to experiments without time and place restrictions. In remote laboratories, learners use the Internet to physically carry out real experiments. Learners get concrete findings utilizing concrete materials and reach actual outcomes, the same asif they were in the real lab environment (Alam, Hadgraft, & Subic, 2014). The following table presents certain characteristics of several laboratory practices:

Table N°2: Characteristics of Several Laboratory Practices.

Feature	Hands on Laboratory		Simulated Laboratory		Remote Controlled Laboratory	
	Advantages	**Disadvantages**	**Advantages**	**Disadvantages**	**Advantages**	**Disadvantages**
Accessibility	Realistic data	Space constraint	No time and space restriction	No interaction with real equipment	No time and space restriction	Virtual presence in the labs
Infrastrutcture	Offer students a sense of reality	Vulnerable to damage and misuse	Good for conceptual understandi ng	Need software update	Offer students to conduct repeat lab	Needs software updating and high speed Internet
Pedagogical	Offer students to collaborate	Supervision is required	Enhanceme nt through animation and virtual reality	No sense of real experiment	Feeling close to real data	Need enhancing both social and design data
Economical	Expensive capital and maintenance cost		Relatively low cost and no maintenance cost		Cost not clear yet but believed to be in between hands on & virtual labs	

Source: Adopted from Alam, Hadgraft, & Subic (2014, p. 292).

4. E-learning for Engineering Education: A New Pedagogy is Emerging

The implementation of e-learning technology offers a chance for surmounting most of the challenges that may appear in traditional engineering instruction (Moeller & Sitzmann, 2012), including:

- Recognizing how to address problems founded on a complex theoretical framework by developing computer simulation and modeling methods.
- Taking into consideration the needs and expectations of various user groups with diverse skill levels, abilities, and learning paces.
- Preventing traditional constraints linked to place, time, and space, as well as granting educational access and equity in educational opportunities.
- Offering flexible educational programs that promote multidimensional learning process.
- Addressing the learning requirements of diverse target groups. In addition to this, comparing conventional and online instruction, e-learning for engineering education provides special educational opportunities to increase students' performances (Noroozi,et.al 2010) including:
- E-learning is essential for engineers since it grants rapid and convenient update of instructional materials- a significant role for this active occupation. This, linked to the

quick transfer of content, allows online materials to be the primary option for several engineering instructors.

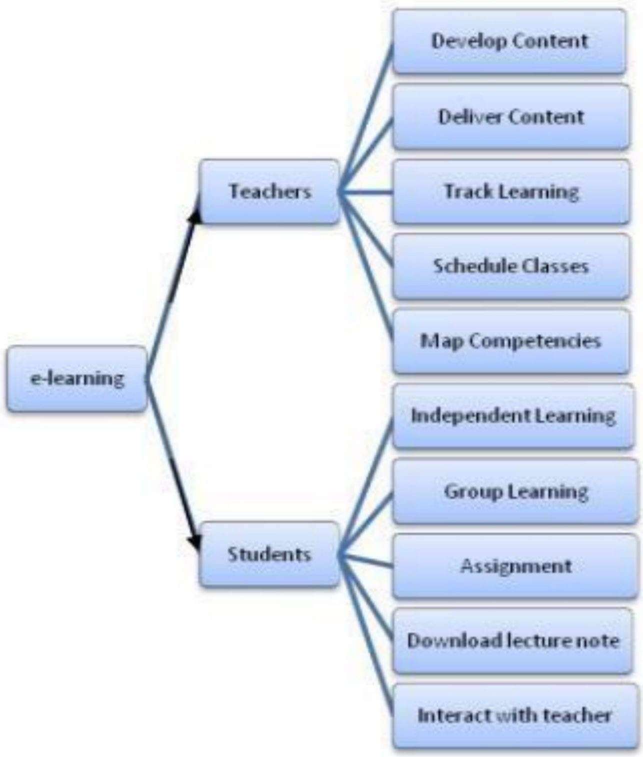
- E-learning offers a convenient method to address the technical issues through the realization of complex physics simulations. Utilizing interactive computer modeling techniques, graphics and visual representations generates enhanced efficiency of the engineering education.
- Visual representations are of vital significance for engineers and online instruction offers inexpensive and efficient tools for disseminating great amount of pictures (through the Internet). Moreover, online instruction can ensure a method of visual manipulation, which has no equivalent in other ways of publications.
- "The search function" provided by several online course materials grants another benefit. This is too crucial for engineers.
- Eventually, since a lot of engineering learners worldwide can access the instructional resources through the orientation of most famous experts has no alternative in the other instructional practices and means of communication.

E-learning system for engineering education is "an educational method that is able to provide opportunities for the needed people, at the right place, with the right contents, and the right time" (Lee & Lee, 2008, as cited in Moeller & Vakilzadian, 2012, p.32). E-learning for engineering education provides particular educational chances to improve student performance: in today's online education, there exists obvious advantages that can be emanated from e-learning:

- E-learning is interactive; the computer software programs allow the engineering learner to interact not just with the instructor, but with their classmates too. It enhances and complements the campus-based learning through the implementation of the Web.
- E-learning supports "interactive and exploratory modes of inquiry"
- E-learning enhances and encourages "team-oriented collaborations"
- Students' grades and content are available online and learners can visit the websites from any place in the globe.
- It is totally opposite from distance education in which an engineering learner is provided with instructional materials and expected to study and solve problems alone until exam period.

- E-learning has the power to provide information continually to students by offering identical notions and knowledge engineering techniques- dissimilar to traditional learning environment, where various teachers may not use the same educational program or instruct diverse elements within the curriculum. The following figure summarizes most of the e-learning benefits to instructors and learners in engineering education:

Figure N°4: E-Learning Benefits to Instructors and Learners.



Source: Adopted from (Singh, 2005; Michau, Gentil, & Barrault, 2001)

The implementation of Information Technology (IT) has become a basic element in multiple course environments. IT uses are not restricted to the classroom; they are substituting certain class meetings with virtual learning classrooms or wholly substituting traditional education by online instruction (Zhao et al, 2012). While more HEIs embrace online education, a number of concerns develop:

- Institutions must ensure an appropriate framework and adequate technical assistance to promote the online activities.
- Teachers and learners must have well developed information technology literacy skills to effectively utilize online tools.
- Educators must restructure their courses and adapt their teaching practices to integrate e-learning efficiently into the instructional experience.

5. Engineering Education and Assessment Practices

Assessment is a form of defense for teachers and educators to demonstrate the outcomes of their rigorous work, and to show how much their students are increasingly learning. According to Salvia, Ysseldyke & Witmer (2009), "assessment is a critical practice engaged in for the purpose of matching instruction to the level of students' skills, monitoring student progress, modifying instruction, and working hard to enhance student competence (p. 17). The development of engineering education relies heavily on assessment. Adequate assessments can equip teachers with information they can use to plan and modify sequences of instruction. Inappropriate and poor assessments may lead teachers to follow inefficient teaching methods. In an engineering education environment, assessment is the key element in determining the students' achievement and monitoring their progress. According to Felder, Sheppard, & Smith (2011) "research, by its nature, requires effective assessment. The infusion of accepted principles and practices of educational assessment are having a significant impact on the development of engineering curricula and the evaluation in terms of student performance" (as cited in Subheesh & Sethy, 2018, p. 4).

Engineering learners involve some skills that would not be assessed efficiently by conventional assessment methods that depend on the reproduction of stored information. Moreover, assessment is designed and performed without establishing the educational goals. One method and one assessment practice are used throughout a course of study. Assessment is considered as just a procedure in which instructors often provide quantitative feedback and rarely qualitative feedback. This usually results in inefficient and ineffective learning experience. Contrary to conventional assessment methods, 'authentic' assessment methods have been set up and are thoroughly corresponded to educational goals. These draw attention to the improvement of learners' academic achievement, competence, and ability. The planning and execution of such assessment practices are seen as professional missions in which majority of the engineering instructors lack proficiency (Rashad et al., 2008).

In higher education, evaluation is fundamentally about making judgments about the worth of something. It relies on the use of quantitative proof/figure (numerical value), and does not involve the qualitative feedback element. Therefore, evaluation is merely quantitative by definition. Unlike evaluation, feedback is an indispensable element of the assessment. The concept of assessment inevitably involves qualitative feedback. Accordingly, assessment can be viewed as qualitative. The feedback involved in assessment is practiced to enhance learners' learning outcomes as well as instructors' teaching experiences (Rashad et al., 2008).

5.1 Types of Classroom Assessments

Formative assessment and summative assessment are both viewed as "types" of assessment. Formative assessment is identified as an assignment or activity that offers feedback for learners about their academic progress (Bell & Cowie, 2006). It does not involve a quantitative grade; rather, it includes a qualitative feedback element. Formative assessment attempts to assist learners improve self-consciousness and self-regulation skills, and reinforce their learning practices in connection to the desired learning outcomes of the educational program. In a formative assessment, learners become involved in taking an active role in assessing their own learning and realize what has been improved, ignored or missed.

The practical side of engineering education, by means of hands-on sessions in laboratories and practical project assignments, is crucial and can be regarded as supplementing the theoretical classroom knowledge. Laboratory experimentation and field investigations are excellent ways to assess students' knowledge. The instructor can also assess the groups' learning through assigning group projects; however, it should be mentioned that assigning learners with a group project does not ensure that the learning will occur in a group. The group project may be partitioned into sub teams so that each team will work on a specific task. This will make the mission of assessing the group's learning complicated. In such a situation, the instructor may propose peer assessment so that the learners check and examine each other's outcomes. Thus, this can strengthen the learning efficiency because all learners will be engaged in the learning process (Harlen, 2007).

Summative assessment refers to activities and assignments that evaluate students' learning and academic achievement. It is conducted periodically and provides students with grades on their performances in the course. Summative assessment grades are utilized to rank students from high to low achievers (Oermann & Gaberson, 2014). On the other hand, assessing students and particularly through formative assessment is time consuming, it involves a lot of work from instructors to monitor each student's performance particularly when teaching large classes; consequently, instructions do not consider all of the measures involved in formative assessments (Barron et al., 1998, as cited in Luminou & Smith, 2012).

5.2 Towards E-Assessment Models

The rapid expansion of information and computer technologies has granted instructors the chance to appropriately provide individual feedback to learners "e-assessments" by 68 approaching the problems of the number of learners and instructors' time constraints.

Significantly, Internet technologies, e-learning platforms, and online learning environments like MOOC, Moodle, and others enable learners to fulfill their requirements and to employ it in a way commensurate with their learning styles (Luminou & Smith, 2012). Such systems permit instructors to plan e-assessments (once) and utilize them countless times, whereas additional online tools like wikis, chat rooms, e-mails, etc. could improve the online interaction and dialogue between teachers and students. Due to the higher flexibility, cost and time efficiency, e-assessments are gradually implemented into several colleges' educational programs around the globe. E-assessments enable instructors to provide learners with feedbackfaster and they are also easier in contrast to written examinations. By determining learners' common errors on particular issues and their misunderstandings on particular cognitive matters,instructors can readily adjust their instruction methods to satisfy learners' requirements.Furthermore, many scholars have examined how e-assessment should be planned so as to offerlearners the chance to carry out more autonomous self-assessment, acquire feedback, and identify mistakes (Oermann & Gaberson, 2014).

The quick feedback provides learners the possibility to progress by learning from their mistakes and reviewing their answers without relying on instructors. A set of various types of questions including short answer, true and false, multiple-choice and matching exercises and so on can be useful means for learning (Luminou & Smith, 2012). Apparently, "assessment must be a continuous process that facilitates 'online learning' instructional decision making inthe classroom" (Gitomer and Duschl, 1995, as cited in Bell & Cowie, 2006, p. 24). Eventually, educational policy should consider the significance of assessment design to improve learners' learning. The following criteria should be taken into account when designing assessment tests in engineering courses:

- They are linked to the instructional method(s) adopted by the instructor.
- They are adequately linked to the desired learning results and assessment requirements of the course.
- They are permanently evaluated by the learners and instructors to enhance their quality and effect on learning to guarantee that they are effective, fair, adaptable and viable.
- Their content and instructions are precise, unambiguous, and clear.

Conclusion

E-learning system is constantly growing and it needs modern methods to stimulate the learners. In fact, there is a need to ensure that the technology employed in the online learning environment promotes the active engagement of the learners. Watts-Taffe & Clarke (2014) argue "while we may use some wonderful technology tools in our classrooms, we need to be thoughtful about how these tools can be used to position our students as learners" (p. 45). When we employ technology as a learning aid, it is important to consider how these tools operate to involve the learners in the learning process so as to promote active learning. Learners, thus, become self-directed as they have the freedom to choose what to learn and how to learn it; at the same time, they become active participants in their own learning. The students in higher education institutions, particularly, are categorized as mature learners; the majority of them are beyond the age of eighteen, they are more conscious about their educational objectives and able to take control of their own career direction.

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