E-learning in engineering education – General challenges and the Egyptian experience

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Abstract
E-learning or web-based instruction is being rapidly embraced by most universities across the world as such media of instruction are economical, convenient and disbursable to a larger audience. In engineering education, in particular, web-mediated techniques have been receiving more attention as they suitably combine both aspects of computer-assisted learning methodologies with the access feature of the Internet at the client end. Various disciplines of engineering are receiving diverse models based on e-learning, where current technologies are redefining the concept of distance learning and the delivery of engineering education content.

This paper begins by discussing the challenges, which e-learning-based engineering education is generally facing. These challenges are then reviewed from an Egyptian perspective, where particular local impediments are highlighted with their impact on both continuing education of graduate engineers as well as degree-seeking engineering students. Egyptian efforts –probably exemplifying most developing countries- are then described and assessed.

The paper also presents a set of issues, with which most developing countries, such as Egypt, should be aware. This is translated into a corresponding set of recommendations that constitute a road map to the sustainable use of e-learning in engineering education.

1. Introduction

The world is witnessing an explosion of on-line and distance learning practices, which are attributed to a number of factors. These factors, which are largely valid in developing countries (such as Egypt) as well as developed (advanced) countries, are recent advances in information technology, the declining cost of computers, impressive increase in access to the Internet, continuously improved quality of multimedia software, the need of corporations to maintain a competitive workforce in the globalized economy, the desire of non-traditional student's to eliminate the skill gap with traditional university students, and the tremendous increase in the magnitude of information (Dutta, 2002; Fukumoto, 2002; Gudimetla, 2010; Lo, 2009). Engineering education, in particular, will need to use ICT to advance the learning process, make learning more effective, and more universal (Moscinski, 2008; Peterson, 2002).

To support the validity of adopting e-learning in engineering education, the Institute of Electrical and Electronics Engineers (IEEE) identified what was termed the fourteen engineering challenges of the future (Perry, 2009). Two of those challenges are rightfully served by e-learning, namely:

- "*To enhance virtual reality*",   and
- "*To advance personalized learning*"

Also, as will be detailed later in the paper, the American Accreditation Board for Engineering and Technology (ABET), in addressing the one major challenge facing the application of e-learning to engineering education, namely laboratories, confirmed that the objectives for engineering laboratories are largely met through online education (ABET, 2009).

Evidence has been reported on the success of practicing e-learning in all disciplines including engineering, where no significant differences in learning outcomes of e-learning students from their on-campus counterparts as measured by test scores (Abdellah, 2007). The social connectivity between learners has been maintained and enhanced, the long-term costs of e-learning are comparable to those of on-campus education, and academic staff as well as students is largely satisfied with online education (Bourne, 2005).

2. Specific merits of using e-learning in engineering education

It has been demonstrated that the following competencies, which are identified by the Accreditation Board for Engineering and Technology (ABET), (ABET, 2009; Pitchian, 2002; Sarangi, 2004), are enhanced by e-learning:-

1-the ability to apply knowledge of mathematics and science, 2-the ability to design and conduct experiments, as well as analyze and interpret data, 3-the ability to design a system, component, or process to meet designed needs, 4-the ability to function on multidisciplinary teams, 5-the ability to identify, formulate, and solve engineering problems, 6-the understanding of professional and ethical responsibility, 7-the ability to communicate effectively the broad education necessary to understand the impact of engineering solutions in a global and societal context, 8-the ability to engage in, lifelong learning, the knowledge of contemporary issues, and 9- the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice .

However, many challenges remain to face e-learning-based engineering education. It should be noted that these challenges –although generally valid- present themselves with different magnitudes from one educational environment to another and from one country to another.

3. General challenges of e-learning in engineering education

As confirmed by international experience, initial partial application of e-learning in some institutions in Egypt led scholars to realize that the following issues have been identified to pose a challenge to the application of e-learning to engineering education (Abdellah, 2007; Peterson, 2002):-

- Identifying the skills required by admitted students.
- Evaluating the progress of students.
- Identifying the appropriate teaching strategy.
- Choosing to use electronic means in laboratory work and the resource required for sharing remote labs.
- Accrediting e-learning-based engineering programs.
- Setting regulations for credit transfer in engineering especially with campus-based institutions.
- Targeting interactions with international engineering education bodies (Jones, 2002).
- Estimating the cost of resources serving online engineering education.

- Facing inevitable new changes in teaching loads and the trade-offs in teachers' time between online and on-campus teaching.
- Estimating human and technical infrastructure required.
- Assessing student and staff satisfaction.
- Facing changes in student advising protocols.
- Assessing class software requirements.

4. The issue of engineering laboratories in e-Learning

One of the major challenges facing the application of e-learning in engineering education is the students' laboratory work, which would necessarily differ from that in a campus-based curriculum. ABET engineering criteria states that: "*All engineering programs must demonstrate that their graduates have 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 further identified 13 objectives for engineering class laboratory

1. Instrumentation: Apply appropriate sensors, instrumentation, and/or software tools.
2. Models: Identify the strengths and limitations of theoretical models as predictors of real world behaviors.
3. Experiment: Devise an experimental approach.
4. Data Analysis: Demonstrate the ability to collect, analyze, and interpret data.
5. Design: Design, build, or assemble a part, product, or system.
6. Learn from Failure: Recognize unsuccessful outcomes due to faulty equipment, parts, code, construction, process, or design.
7. Creativity: Demonstrate creativity in real-world problem solving.
8. Psychomotor: Demonstrate competence in selection, modification, and operation of engineering tools.
9. Safety: Recognize health, safety, and environmental issues.
10. Communication: Communicate effectively about laboratory work with a specific audience.
11. Teamwork: Work effectively in teams
12. Ethics in the Lab: Behave with highest ethical standards, including reporting information objectively and interacting with integrity.
13. Sensory Awareness: Use the human senses to gather information and to make engineering judgments.

Many of Egyptian scholars now believe that all criteria may be met as easily online as in a campus lab environment. Furthermore, some believe that *"Laboratories contributed little to undergraduate engineering education because the experiments involved technologies that either changed rapidly or became obsolete."* (Hung, 2007).

4.1 Laboratories in e-learning- engineering education

In an engineering program, which uses e-learning, laboratories may take one or both of the following two modes:

1) <u>Laboratory Simulations</u>, where experiments are simulated on computers and are well interactive. Examples are found in *National Instruments DAQ (data acquisition), Field Point, Measurement Studio, LabVIEW…..* This practice is relatively low in cost and significantly increases student access (Gowdy, 2002; Hung, 2007). The highest level of this technique is classified as "virtual reality" (Klett, 2002).

2) Remotely controlled physical laboratories, where physical laboratory equipment is used yet they are located away from where students perform experiments (Bing, 2010; Wen-Hsiung, 2008). This way many institutions may share common physical laboratories. Examples of online laboratory Web sites are found in:

MIT (weblab.mit.edu), Johns Hopkins U. (www.jhu.edu/~virtlab/virtlab.html), U. of Texas (www.robotics.utexas.edu/simulations).

5. Motivation of e-learning in university education in Egypt

With a population of nearly 84 million, Egypt has 19 public and 17 private universities (as of November 2010). Public universities enroll nearly 97% of all Egypt's university students. The total university student body is 2 million students strong. Another 500 thousand students are enrolled in higher institutes. The total number of students enrolled in university engineering programs is 158 thousands (31% females), 93.2% of whom attend public universities. Another 100 thousand students study engineering/technology in higher institutes.

In 2002 the Egyptian Government introduced a new cabinet portfolio for "Communications and Information Technology, CIT" reflecting the country's desire to actively harness information technology to serve public services including higher education. Statistics quoted here are in part found in (Abdellah, 2007).

Egypt's motivation to introduce and adopt e-learning is based on the following factors, with special consideration to engineering education:

1. The desire to improve the quality of instruction in universities. Engineering education is among the disciplines that should always be kept in pace with international development and advances, something that e-learning aims to achieve (Kudrjavtseva, 2002; Li, 2002 Siller, 2002; Zvonov, 2008). It should also help engineering education –a traditionally "urban" discipline- reach remote areas. Other positive impacts on learning in engineering programs include:
   - Developing technology skills.
   - Accommodating the diverse needs of engineering students.
   - Facilitating efficient cooperation and team-oriented collaborations among students.
   - Catering to the industry’s request of emphasis on skills and deep understanding.
   - Sharing information with other universities and corporations.

2. Facilitate combining work and study – a vital issue to engineering students in Egypt and also in many other countries (Orero, 2006).
3. Increase access. In Egypt, higher education scores a modest *Participation Ratio* of about 29%; the Government aspires for a 40% ratio within 10 years. Access also implies that engineering students would have access to all sources of technical knowledge and information. For this to be well achieved, communication systems and infrastructure would have to be adequate, and –also- all students should be provided with access to computers and internet service
4. Combat the present crowding in public higher education institutions, which results from accommodating nearly 2 million students in a limited number of institutions, which –in turn- reflects adversely on education quality.
5. Ease the current large average students-to-teachers ratio of nearly 30:1.
6. Egypt is targeted to be the hub of e-Learning in Arab Region.

7. The aspiration for being able to export e-learning technology to the outside world, especially Africa, Middle East and Arab countries.
8. Reducing education cost, where the use of e-learning is generally expected to cut on the cost of buildings, teachers' salaries, classroom costs, transportation cost, .., and many other cost components.

Egyptian scholars now emphasize that when considering applying e-learning in engineering education in Egyptian universities, blended (or, hybrid) mode of learning is being found to be most appropriate, where on-campus courses are blended with online courses (UAE Government, 2009). Pure distance engineering education in an open learning environment assumes an inferior priority, because of the current academic resistance to this mode. Also, formal, degree-bound, education is assigned a secondary priority to continuing professional education for the same reason. The latter may take the form of short (crash) courses or in-house training courses.

5.1 E-learning technologies in Egypt

Only during the past seven years that the notion of using online courses was entertained in university education. Authoring e-learning courseware has been encouraged by UNESCO and through a World Bank project. Synchronous (or, real time) instruction is extremely rare. The use of web-based courseware is strictly for asynchronous (or, archived) purposes, which are found to have the added advantage of simultaneously using such off-line interactive tools as blogs, wikis, collaborative software, e-Portfolios, discussion boards, and email.

It has been realized that, in creating e-courseware, several tiers of e-course contents are recognized. In an ascending order of comprehension, thus complexity, the e-material may:

- Contain only the course structure and assignments.
- Add text material.
- Add references and links (in hypertext) to supplementary reading.
- Add illustrations.
- Add audio/video clips.
- Add simulations and animations.
- Include interactive virtual reality.

From the experience gained in Egypt and in other developing countries, implementing e-learning-based programs runs the risk of incompatibility between the targeted educational functions and the enacted technologies. Such incompatibility influences the cost (both capital and operating) and the quality of learning of the program as demonstrated in Figure (1). An educational function, which is more ambitious than what the available technologies can provide, results in low education quality. On the other hand, technologies that are significantly more advanced than what the targeted function requires implies waste of resources and operation problems.

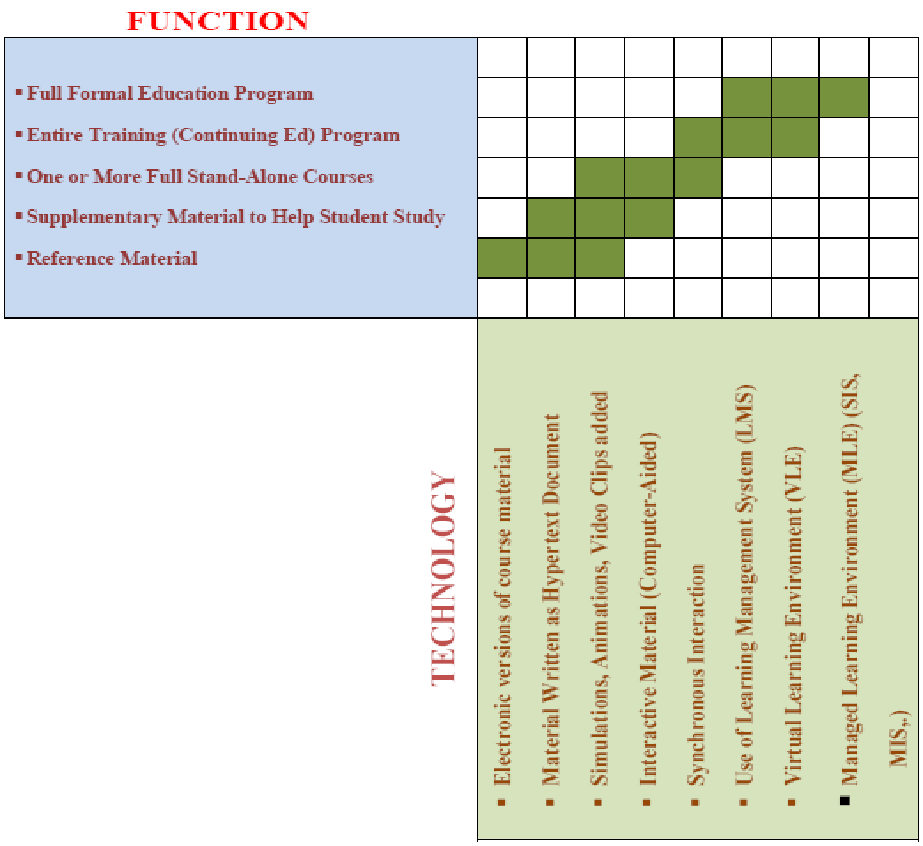

Figure (1) Hierarchy of e-learning technologies and the corresponding educational functions; the central shaded zone signifies proper match.

6. Accreditation of e-learning-based engineering education

Accrediting engineering programs appear to be more complex than their classical class-based counterparts for they need to undergo more tiers of recognition and thus comply with more sets of criteria. In Egypt, accreditation is the responsibility of the National Accreditation and Quality Assurance Agency of Egypt (NAQAAE). It involves the following two main procedures:

1) Traditional institutional accreditation, which assesses such factors as Students: (admission policies , learning experience, progress, assessment…etc), Quality of Delivery, Staff and Staff Development**,** Support Services: (libraries, student counseling...etc), Administrative Services: (registration and personnel functions….etc), Physical Resources**: (**laboratories, classrooms..etc**),** Quality Control, Records, ..

2) Program (Professional, Discipline..) Accreditation**,** which primarily targets the curricula as well as most of the above factors as required by the specific program.

When e-learning is involved two additional sets of criteria (and, hence, procedures) are seen to be necessary:

3) E-learning-specific Institutional & Program accreditation, where the above mentioned elements of evaluation are still abided by, yet they are viewed from e-learning application perspective. In other words, the educational system is judged on whether it appropriately utilizes e-learning concepts and procedures to promote the educational process.

4) Courseware certification**,** involving specialized groups of assessors who focus on: efficiency of interface, course compatibility, production quality, and the appropriateness of instructional design.

7. Egyptian efforts in applying e-learning to engineering education

Sporadic and rather individual efforts have been made in the way of applying e-learning techniques to engineering education in Egypt. So far, those efforts have been informal and serve as supplementary to campus-base formal courses. The following examples are worth mentioning:

The Egypteducation Site: (http://www.egypteducation.org/moodle/) invites professors to add online courseware materials in all engineering disciplines. It is based on the open-source learning management system, Moodle, and is hosted on a Virtual Private Server (VPS) in the USA. It is currently used by over 80 instructors and has about 16,000 registered users, mostly in Cairo University, which the by far the largest university.

YouTube Site: (www.youtube.com/sfateen) presents lectures, in which engineering instruction is in local Arabic with English technical terms.

Using Learning Management Systems: LMS "Moodle" is currently used in a number of courses in a number of engineering colleges, where it serves the following functions:

> online exams, announcements, links to some other universities that offer the same course, following up the students interests in reading and downloading material, online submission of assignments and projects (*proven by experiences in Cairo University and other smaller universities not to be very successful*).

7.1 Egypt's National E-Learning Center (NELC)

Six years ago –in a general effort to enhance higher education- the National E-Learning Center (NELC) was established. The NELC has been affiliated with the Supreme Council of Universities (SCU), which coordinates educational processes and criteria in public universities. One major consideration was given to the issue of the source of e-learning courseware. Three sources were initially considered, namely:

1. Free courseware, such as: the Open Course Ware (MIT), Open Learning Initiative, Connexions (Wikipedia style),.etc. This solution is economical but it does not build the institution's capacity in the e-learning area.
2. Purchased courseware available in public domain at publishers. This approach is generally uneconomical especially in developing countries such as Egypt.
3. In-house-developed courseware. This solution –although cost is involved- builds the institutions' capacity, and was generally preferred by Egyptian authorities and institutions.

The NELC has been assigned to carry out the following tasks in Egyptian public universities;

- To create e-learning sub-centres in all universities.
- To build adequate e-learning infrastructure.
- To support the development of e-courses.
- To provide e-course development standards.
- To certify e-courses to be used by universities.
- To monitor the use of e-courses.
- To coordinate e-learning development at the national level.
- To provide necessary information, training and support.

7.2 NELC's achievements

- E-learning sub-centers have been established in all 19 public Egyptian universities. The target was to appoint the following staff in each center: centre director, 1-3 instructional designers, 2-4 e-content developers, 3-4 graphics designers, Training coordinator & 1-2 executive secretaries. This was only achieved with varying degrees of success. Adequate hardware and software were also provided.
- Only 10 universities (out of 19) contributed to the development of in-house online courses.
- The number of in-house developed online engineering courses was relatively low (7 courses out of a total of 292 courses (2.4%) *as of August 2010*).
- A number of e-learning-related training programs were delivered to faculty members and staff.
- A program has been initiated for promoting and funding Virtual Laboratories in Universities in six areas none of which is engineering (chemistry, physics, biology, anatomy, physiology, and accounting and economics).

7.3 Alternative approach by NELC

To overcome the marked shortness in engineering e-course development the NELC has shifted its support from full courses to their building blocks (Hodgins, 2002; McClellan, 2004). E-course content hierarchy may be generally classified in the following order of complexity:

- Data or Raw Media Elements.
- Information Object , which is a set of data elements.
- Reusable Learning Object (RLO), or simply LO. This is a combination of information objects that include: Concepts, Facts, Processes, Principles, Command References, Exercises or Procedures).
- Course (or, lesson), which is a combination of RLOs.
- Module, which is a collection of courses or subjects.

The NELC is now supporting the development of LO's for engineering courses, but also for other disciplines. The fact that developing an LO is simpler, easier to manage, requires less time and cost than a full course is encouraging professors to get involved. A total of 850 LO's, serving 70 e-courses, have been developed in a relatively short period.

The NELC is undertaking the task of activating e-courseware in ongoing programs. The overall share of e-courses increased from 5.46% in 2007/2008 to 20.09% in 2009/2010. It is estimated that e-courses are now accessible (and usable) to nearly 73 thousand students.

8. Impediments to engineering education based on e-learning

Some of the specific obstacles to applying e-learning to engineering education in Egypt are:

8.1 Academic factors:

1. Lack of academic and administrative readiness, where the majority of engineering educators still look upon on-line learning with reservation. Such reservation extends to administrators including members of national education committees.
2. Shortage in on-line courseware. This is caused by lack of interest in foreign-authored material coupled with slow local production as explained elsewhere in this paper.
3. Social/cultural resistance – of the public and the industry alike- to any form of learning that is short of full campus education. This is particularly true in engineering.
4. Complex legal consequences, e.g. IPRs, of online courseware authoring.
5. Absence of formal clear procedures and criteria for nationally accrediting online programs.
6. Increase in teaching load at the expense of other functions.

8.2 Technical factors

1) Availability of suitable infrastructure. Although it was markedly improved over the past five years, the IT infrastructure at universities remains short of supporting comprehensive e-learning programs.
2) Accessibility of computers and Internet services to students. This is a major obstacle in most developing nations.
3) Difficulty in choosing media and technologies.

8.3 Economical factors

1) The initial high capital cost of e-learning, especially in engineering, is deterring Egyptian university decision-makers to invest in this mode of education.
2) Some of the relatively high cost items are:
    - Cost of producing and/or purchasing courseware materials. (Cost of developing a 3-credits e-course in Egypt ranges from $ 2000.- to 10,000.-) .

- Cost of instruction online (preparation, training,…)
- Cost of providing network services.
- Cost of acquiring a learning management setup (LMS, SIS, assessment,..).
- Cost of technical and educational infrastructure.

3) Determining the economical break-even number of students (course population) and the corresponding courseware lifetime length is a costly undertaking.

9. Issues to be addressed & recommendations for Egypt

A number of critical issues need to be addressed for a sustainable and largely comprehensive e-learning-based engineering education to be established in Egypt. These issues, in turn, lead to a number of corresponding specific recommendations:

- The skills and experiences of the new generation of students need to be well identified and capitalized on, while examining ways to enhance e-tech motivation for students.
- The skills and experiences of the teaching staff (present and future) need to be recognized and assessed.
- A campaign is necessary to increase the awareness of e-learning benefits in engineering, which would eventually promote willingness to change the learning paradigm.
- Potential authors, designers, and technologies need to be evaluated.
- The best technical infrastructure to support such an endeavor is to be sought.
- New organizational structures built around e-learning in engineering education may need to be planned.
- Practical accreditation and certification criteria should be clearly set, which while maintaining education quality, recognizes the powers of e-learning.
- Finding ways to lower e-course costs, and finding ways to fund the development of large quantities of multimedia learning materials.
- Benefitting from recent experience, e-learning should be prioritized by first applying it to certificate programs, to be then followed by post-graduate engineering programs and lastly undergraduate programs.
- Soft laboratories should first be implemented followed by seeking remote laboratories.

10. References

Abdellah, G. and Taher, S. (2007) 'Recent developments in Egyptian engineering education through competitive projects', *Formal Egyptian Government report*, Egypt.

ABT -Accreditation Board for Engineering and Technology (2009) "Criteria for accrediting engineering programs", *Engineering Accreditation Commission Publication*, USA.

ABET -Accreditation Board for Engineering and Technology (2009) "Accreditation policy and procedure manual", *Engineering Accreditation Commission Publication*, USA.

Bing, D., and Voon, L.K. (2010) 'Developing a Scalable and Reliable Online Laboratory for Engineering Education Using NI Products', *National Instruments* Company.

Bourne, J., Harris, D., Mayadas, F. (2005) 'Online Engineering Education: Learning Anywhere, Anytime', *Journal of Engineering Education*.

Dutta, D. and Taghaboni-Dutta, F. (2002) 'E-Technologies in Interdisciplinary Education: Engineering and Business Perspectives', *ECI Conference on e-Technologies in Engineering Education: Learning Outcomes Providing Future Possibilities*, Davos, Switzerland.

Fukumoto, M. et al (2002) 'An approach to e-learning aimed at knowledge management', *ECI Conference on e-Technologies in Engineering Education: Learning outcomes providing future possibilities*.

Gowdy, J.N., Patterson, E.K., Wu, D., Niska, S. (2002) 'Development and Use of Simulation Modules for Teaching a Distance-Learning Course on Digital Processing of Speech Signals', *ECI Conference on e-Technologies in Engineering Education: Learning Outcomes Providing Future Possibilities,* Davos, Switzerland.
Gudimetla, P. and Iyer, R.M. (2010) 'The role for E-learning in engineering education: creating quality support structures to complement traditional learning', *e-Prints of the Queensland University of Technology*, Australia.
Gupta, A. (2002) 'Content Development for eLearning in Engineering Education', Interactive *Educational Multimedia*, number 4, pp. 12-23.
Hodgins, H.W. (2002) 'The Future of Learning Objects', ECI *Conference on e-Technologies in Engineering Education: Learning Outcomes Providing Future Possibilities*, Davos, Switzerland.
Hung, T-C, et al (2007) 'The Establishment of an Interactive E-learning System for Engineering Fluid Flow and Heat Transfer', *Proceedings of the International Conference on Engineering Education (ICEE*).
Jones, R.C., Oberst, B.S., Siller, T.J., Johnson, G.R. (2002) 'International Exposure for Engineering Students Using Distance Learning Techniques', *ECI Conference on e-Technologies in Engineering Education: Learning Outcomes Providing Future Possibilities*, Davos, Switzerland.
Klett, F. (2002) 'Improving Engineering Student Learning in a Web-based Learning Space Due to Virtual Reality Techniques and Advanced Interactivity', *ECI Conference on e-Technologies in Engineering Education: Learning Outcomes Providing Future Possibilities,* Davos, Switzerland.
Kudrjavtseva, S. (2002) 'e-Technologies in Engineering Education: A Case of Pedagogy Development', ECI Conference on e-Technologies in Engineering Education: Learning Outcomes Providing Future Possibilities, Davos, Switzerland.
Li, K., Cocke, D.L., Gossage, J.L. (2002) 'Problem-based Learning in a Multi-electronic Media Classroom', *ECI Conference on e-Technologies in Engineering Education: Learning Outcomes Providing Future Possibilities*, Davos, Switzerland.
Lo, W.-S., Chung, I.C., Hsu, H.J. (2009) 'Using Ontological Engineering Approach for Engineering Education e-Learning System', *Proceedings of the International Conference on Engineering Education (ICEE*).
McClellan, J.H. (2004) 'Computer-enhanced Course Material for Introductory Engineering Courses', *ECI Conference on e-Technologies in Engineering Education: Learning Outcomes Providing Future Possibilities*, Davos, Switzerland.
Moscinski, J. (2008) 'E-learning platforms and quality of engineering education', *Proceedings of the International Conference on Engineering Education (ICEE).*
Orero, E. et. al (2006) 'Lifelong learning observatory for continuing engineering education needs detection', *Proceedings of the 10th IACEE World Conference on Continuing Education*
Perry, W. et. al. (2009) 'Grand challenges for Engineering', *Institute of Electrical and Electronics Engineers, IEEE Spectrum*, USA.
Peterson, G.D. and Feisel, L.D. (2002) ' e-Learning: The Challenge for Engineering Education', *ECI Conference on e-Technologies in Engineering Education: Learning Outcomes Providing Future Possibilities*, Davos, Switzerland.
Pitchian, A.S. and Churchill, D. (2002) 'E-Learning Design for Engineering Education', *Fourth Asia-Pacific Conference on Problem-Based Learning*, Hatyai, Songkola, Thailand.
Sarangi, S.K. (2004) 'Continuing Engineering Education through E-learning: A strategy for development', *International Association for Continuing Engineering Education News Letter*.

Siller, T.J.and Johnson, G.R. (2002) 'E-Technologies for Improving Engineering Education at a Distance', *ECI Conference on e-Technologies in Engineering Education: Learning Outcomes Providing Future Possibilities*, Davos, Switzerland.
United Arab Emirates Government (2009) 'Edutech introduces 'hybrid learning' solution in engineering education', *AlBawaba News Letter*.
Wen-Hsiung, et.al (2008) 'Development and assessment of WSISLE-CNC for engineering education', *Proceedings of the World Congress on Engineering and Computer Sciences*, San Francisco, USA.
Zvonov, V. ; Kulagin, V. ; Mezhenin, A. (2008) 'New Technologies in E-learning and Creative Pedagogic in Continuous Engineering Education', IACEE *11th World Conference on Continuing Engineering Education, Georgia Institute of Technology-Distance Learning and Professional Education,* USA.