Challenges in Engineering Education in the United Arab Emirates

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Abstract
Strategies for teaching engineering in the United Arab Emirates (UAE) have been evolving over the past decades due to innovations in technology, as well as the development of educational methodologies. In the recent past, the focus for engineering faculty has been not only on promoting the skills needed to raise the level of employability of Emirati graduates, but increasingly on new educational methodologies, e-learning and wireless networked laptop technology. Students in the UAE exhibit certain characteristics emerging from a variety of cultural and historical traditions, as well as from methodologies of education used at the pre-tertiary levels. These characteristics include expecting to be passive recipients of taught information, and lack of independence in their approach to problem solving. In this paper I discuss the development of strategies to facilitate the transition of students from passive to active learning; examine the role of technology-driven educational methodologies in promoting independent and group-centered learning skills; and use a case study to explore the instruction of Engineering Design and Computer-Aided Design (CAD) and to examine how classroom management techniques have changed as a result of the growing use of technology.

Introduction

The development of taught courses and curriculum is an ongoing and ceaseless process, with retraining of instructors being necessary and frequent in order to keep pace with technological and other advances and in order for these instructors (be they early or late adoptors) to comfortably appreciate and implement such technology (McKenzie, 1999). Additionally, some observers feel that the entire educational system in the Arab world as a whole is in desperate need of an overhaul (Al-Maeena, 1997). Understanding the needs of company management is also important at the educational level in engineering departments, in spite of graduates often becoming part of a National workforce where employment is guaranteed. Sectors of particular importance for engineers in the UAE are oil and gas, IT, civil and infrastructure and manufacturing. Employers in these areas are increasingly expressing the need for graduates ready to work rather than having to be re-trained on variations of a given technology.

The College of Engineering at UAE University, during the early period after its foundation (1980-1992), followed a classical curricular pattern similar to that dominant in the region. This was characterised by compulsory taught courses based on purely quantitative content and teaching through lecture-based classes. Realizing that tomorrow's engineer has to face the challenges of modern technology and the demands of modern society, the university administration initiated a major effort to modernize the engineering curriculum and to parallel the most recent international trends, particularly the curricula promoted in the USA, as well as other developed countries. Thus the college now focuses on the evaluation of learning outcomes of students in line with ABET (Accreditation Board for Engineering and Technology) requirements. Accreditation from an international body such as ABET is of particular importance at present, particularly as the UAE is striving for greater regional and

international recognition at all levels of society, particularly in education. Engineering colleges thus realise that effective national growth and development can only be achieved through educated nationals of equal standing in a global arena.

The computer and other information technologies have already revolutionized engineering practice. They are, however, only recently beginning to revolutionize the way engineering subjects are taught (Byron-Pipes and Wilson, 1996). Modernization of teaching methodology for the Engineering Design and Graphics course at UAEU followed the trend adopted in the freshman-year curriculum. Five taught courses were developed in 1996, and five more were implemented the following year. In the teaching of all these courses, the conventional lecture method, in which the engineering instructor recites and demonstrates information and concepts, was reduced to a minimum. In the newly developed approach, the engineering instructor is to assume the role of "manager of learning". In this format, the student is led through a series of activities that will enable him to master fundamental concepts. Nowhere is the approach more evident than in the Engineering Design and Graphics course.

This review considers the effect of active learning on independent and student-centered learning, on the one hand, and the impact of the use of new technologies on both academic staff and students on the other. The data gathering was based on subjective observation by the Author, within and beyond the classroom environment, between the Fall semester of 1999 and Spring semester of 2004.

Active Learning

Active and independent learning is fundamentally about creating the pedagogical, social, and ethical conditions under which students agree to take charge of their own learning, both individually and collectively. Therefore, the goal of an active learning strategy is to teach in a way that engages students in learning. As such, teaching consists of getting students involved in the active construction of knowledge. Thus, the aim is not only to transmit information, but also to transform students from passive recipients of other people's knowledge into active constructors of their own and others' knowledge. This is likely to have a significant impact on society, in a broader context than simply within educational establishments. The reason is that active learning is about empowering students and encouraging independent and critical thinking, and building initiative. These qualities are highly needed in Middle Eastern society at large, and the engineer of the future will require these skills, if the UAE is to develop into a competitive knowledge-based economy that is at the forefront of industry and commerce in the region.

To implement active learning as a viable strategy, the instructor must consider four key objectives in every classroom session: activity, reflection, collaboration and passion (Roland Christensen et al., 1991). The class time should be managed so that it is not only a fifty minute lecture in the traditional sense, but rather that the class time is broken into distinct blocks of learning. For example, this could begin with a 10-20 minute introductory mini-lecture, followed by a 15-20 minute small group activity, followed by 5-10 minutes of group feedback and finishing off with concluding remarks and learning outcomes from the instructor.

There are numerous active learning methods and approaches that are facilitated by new technologies, and their application often varies from one discipline to another, often within the same faculty. These various methods are valuable in assisting the development and

restructuring of taught courses. Some of them are outlined here. For example, 'engaged learning' deals with increased and focused student interaction, as well as collaboration amongst instructors and students. The focus is on the instructor as a facilitator and an emphasis is placed on technology as a tool for learning.

Cooperative learning (CL) is a generic term for various small group interactive instructional procedures. Students work together on academic tasks in small groups to help themselves and their team-mates learn together. CL involves people working in teams to accomplish a common goal. It consists of various key concepts. The most essential of these are positive interdependence, where all members must cooperate to complete the assigned task, individual and group accountability, where each member is accountable for the complete final outcome, face-to-face promotive interaction, teamwork skills and group processing. Perkins (2003) argues that optimization of group size is also critical for effective CL. An important factor is synergy, whereby cooperation amongst an optimum number of individuals enhances the collective intelligence quotient (CIQ) of the whole team. However, importantly in a classroom environment, the group size should be restricted. This view is also supported since a group size of three or four seems to be optimum from the perspective of CIQ, and group sizes greater than this can be detrimental for individual activity.

Project-based learning deals with real-world issues in engineering and requires a sustained period of team-based investigation in the completion of a project or task. Problem-based learning is a related philosophy of teaching and learning, in which students work together to solve problems of priority to them and to their community through input from experts, research, and the collaborative testing of potential solutions. Structured problem solving can be used in conjunction with other cooperative learning structures.

One more recent consideration among those involved in active learning strategy is the concept of intensive and reflective learning, where, rather than having an evenly spread curriculum for a taught course, say over a sixteen week period, instead, "blocks" of intensive teaching are introduced, followed by periods of enhanced learning through research, reflection and reporting. This method, though valuable in the West, can prove problematic in the Gulf, particularly at the (early) undergraduate levels, where a cultural shift towards independent learning is still needed. However, new technologies have enhanced this thinking, as the use of email, discussion boards, chat, video walls, etc have facilitated and structured interaction between student and instructor during the blocks of reflection.

Challenges

Enhancing learning through the use of technology and new teaching methods is extremely challenging. Furthermore, these challenges are exacerbated for educators in the Middle East for a number of reasons. One such challenge is growing class size, which has become an increasing problem in the UAE. "The greatest single challenge to SMET [Science, Mathematics, Engineering and Technology] pedagogical reform remains the problem of whether and how large classes can be infused with more active and interactive learning methods" (Seymour, 2001). In engineering, student numbers in the UAE have increased so dramatically over the past decade that attempts at keeping up with changes required to enhance team-based learning, classroom dynamic and individual skills testing (e.g. through student presentations) is proving difficult. The main reasons for this sharp rise in student numbers are increasing national population, increasing literacy rates, an increased recogition

of the importance of tertiary education and the growth in demand for educated skilled professionals to drive the implementation of the emiratisation policy.

Another challenge which has grown in recent times, in part due to large classes, is plagiarism and cheating. Although consistency with other international universities (USA in particular) is advisable for a coherent policy on plagiarism, cultural variation must also be taken into account. For example, students in the UAE and in the Middle East in general, have a much greater spirit of cooperation than their contemporaries in the West. Although this in itself is a noble attribute, such students will happily provide their work to a fellow student without considering themselves as unethical; in addition, the student copying the work will regard his colleague as merely helpful. In contrast, students in the West are more competitive and consequently more possessive of their own work; thus, the nature of plagiarizing is largely confined to copying textual and IT sources (Internet) rather than the work of a fellow student. A coherent policy is at the core of dealing with this, though departmental leadership need to be engaged when it comes to the implementation of such policy. The use of software resources has also proved useful in seeking out offenders. Often, simply typing portions of a student's work into an online search engine is sufficient.

Though team learning is a vitally important skill in today's engineering company, adopting active learning strategies to facilitate both implementation and assessment of this type of learning is very difficult in this region. The greatest problem faced by instructors, as well as the studious participant, is the "hitch-hikers and couch potatoes" phenomenon (Oakley, 2002), the former being an individual in the group who is carried with the group by making a minimal, insufficient contribution and the latter one who is simply too lazy to make a contribution, often relying on the committed student to do the work for him. This is not solely limited to the Gulf region (with similar problems surfacing in the West), but it does seem that cultural influences in the region affect the group dynamic in a more adverse way than in the western context.

The value of active learning must be considered within an appropriate context when dealing with students in a Gulf setting. A major issue here is to understand that a positive learning experience can only occur when cultural diversity is appreciated. From an instructor's perspective, development of curricula must reflect an understanding of different teaching styles. In terms of students, consideration of cultural as well as related gender issues is of paramount importance in the region.

One way to look at this is to consider motivational theory and organizational behavior, such as the the notions of "Theory X" and "Theory Y" (McGregor,). Theory X assumes that people inherently dislike doing any work, and that people must be coerced into working to achieve set objectives. Thus, people prefer to be directed. In education, this relates very closely to the mindset of the Gulf archetypal student, where students in the early stages of tertiary education require, expect or get a "spoon-feeding" approach to learning, with little or no critical thinking and no effort beyond the limits of what has been stated by the instructor.

In contrast, Theory Y assumes that people view work as being a natural part of life, accepting as well as seeking responsibility, progression, promotion. This relates well to the archetypal western student who naturally goes beyond the bounds of the classroom dialectic to further explore, research and investigate the subject matter. Traditionally, as a result of these archetypal student types, the Theory X model has over time resulted in the "stick" approach,

where, in order to get valuable work out of students, they are given very specific tasks, each of which is closely related to the marking regime. In contrast, students following the Theory Y model are taught with a bias towards the "carrot" approach, given broader outlines to learning objectives. Thus Theory X is a much more dependent learning style than Theory Y. One goal of an active learning methodology in the Gulf, therefore, is to encourage a shift from Theory X dependent learning guided by the "stick" to Theory Y independent learning encouraged by the "carrot".

Another aspect of motivational theory is outlined by Wood et al. (2002) who suggest that people are inherently motivated by money and will only work according to financial benefits to be gained from the work. By analogy to other extrinsic motivations, the motivating factor for the archetypal Gulf student is their score, or grade point average (GPA). This is evident from both behavior and conversation. Gulf students will invariably ask the point value of any piece before making an attempt at it. Often a student will not turn in a homework assignment if he knows that it was assigned for gaining an understanding of the material, rather than for marks. What such a student fails to ultimately realize, is that through gaining greater understanding of the material, his marks will naturally increase when graded assignments are due. Commonly, this is counteracted by the instructor with the award of bonus marks based on class participation or voluntary homework assignments. Alternatively, class participation could also be used as a tool for dealing with borderline cases. For example, a student scoring a B+ grade, but having participated fully in the classroom, may be ultimately raised to grade A, based on this contribution. The Author has noted that informing students of this practice results in them being more highly motivated; this does not, however, deal with the underlying problem of self-motivation and empowerment.

Another challenge facing students is observed in their information literacy skills. Primarily, they have difficulty in locating and selecting relevant websites and information, and lack techniques for recognizing relevant material within a site and selecting only what is useful. Additionally, understanding large sections of authentic text is problematic as there is often more information than they can cope with, resulting in lack of understanding of the main points. This problem is not restricted to the internet, as students face similar challenges with books. However, the manner in which subject matter is displayed and sought out with the Internet poses its own challenges. Students often cannot recognise differences in text type and genre, for example being unable to distinguish between factual and promotional language, especially where web sites advertise a company or product. These problems are often overcome by narrowing the student's scope by, for example, directing them to certain well-known and researched references with which the instructor is already familiar (Leake et al., 2000).

The pedagogical shift towards active and independent learning has resulted in perhaps the greatest positive shift in tertiary education methodology in recent years. The empowerment of the student is noteworthy, with students often expressing appreciation for a recognition of their maturity as a direct result of this empowerment. Though this paper has highlighted areas where improvement is needed, such as in plagiarism and problems associated with team-based learning techniques, there is a need for continuous improvement and evaluation by academics, in order to overcome these difficulties. Within the College of Engineering, this has been facilitated by monthly meetings to discuss issues and collectively arrive at solutions to these problems, as well as reporting on effectiveness of previously implemented actions.

This develops a sense of ownership of the curricula for the academic as well as developing a fruitful iterative approach to managing the issues.

Case Study: Engineering Design, Computer Aided Design (CAD) and the Use of New Technologies

The Engineering Graphics course at UAEU deals with geometric constructions using 2-D CAD, fundamentals of orthographic projections using both freehand sketching and CAD software, dimensioning techniques, scaling of CAD drawings, isometric sketching, 3-D solid modeling using solid primitives and Boolean operations to create composite solids, coordinate systems and viewing transformations. The Design Project course covers an introduction to the engineering design process, where students work in teams on a project provided by a faculty member. Faculty members serve as project advisors. A final group oral presentation is made to a jury panel composed of faculty members and a final written group report is submitted. It is important for the instructors teaching these courses at the freshman level to have an appreciation for the discipline of interest to the student. At UAE University, College of Engineering, this is by no means a small task, as at this level students remain unsure as to which discipline is of interest to them (Randeree, 2002).

In-class activities were developed that utilize both NetOp (for classroom management) and Blackboard (for content management). This allows for greater student interaction during lecture time, electronic distribution and submission of assignments and quizzes and electronic grading, thus eradicating most paper-based activities and maximizing wireless laptop applications. In practical terms, the instructor circulates around the classroom and can also remotely monitor the students. For example, during assignment work, instructors circulate or remotely monitor the students, giving hints, and checking for understanding.

Five types of software are used in this taught course. Internet Explorer is used by the instructor and the students to search and browse the internet for information about their design project and to access the course materials posted on the UAEU web. AutoCAD is used by the students to complete examples and assignments. NetOp is used by the instructor to monitor students and to remotely control individual student machines (when required). Blackboard is used by the instructor to post and manage course materials on the web, to provide online quizzes and to offer students access to communication tools (e.g., chat, e-mail and forums). Viewlet software is used by the instructor to develop animations that demonstrate the use of AutoCAD. Table 1 outlines how these new technologies have effected change in terms of classroom management. The author began delivering taught courses using the “old delivery method” in late 1999 and use the “new delivery method” was implemented by early 2004 (although note that the current model is a blend of the “new” methods with some use of the “old”).

Table 1: Implementation of New Technologies into the Learning Process (Courtesy of UAE University, College of Engineering).

Consequently, development of the curriculum for the course can take into account the availability of a number of e-learning tools such as web delivery, multimedia development, specialized software, as well as other discipline-specific software and techniques. Figure 1

illustrates the generic model for curriculum development at UAE University, College of Engineering, with a view to integrating the traditional development processes with technology-based subjects and technology-demanding delivery.

Figure 1: Curriculum Development Process [Courtesy of UAE University, College of Engineering].

These new technologies facilitate the development of a paperless environment, allowing academic staff to reduce preparation and assessment time. In addition there is less need for repetition in the classroom, and students can easily be referred to downloadable material which facilitates independent learning. This has given a sense of empowerment to students, with many expressing the feeling of greater control in their learning experience. Academic staff, though requiring time consuming and perhaps costly training at first, have generally accepted these changes as being inevitable, although with some being more sceptical than others. Some aspects of the technology have therefore become "selective". An example of this is online grading: some academics prefer to print student submissions and grade them as hardcopy even though the facility for online assessment exists. This has met with little resistance as it is recognised that a balanced argument exists for and against continuing this assessment method.

It is envisaged that ultimately all of the current course materials will be transformed into a digital format and posted on the web using Blackboard. This will require further animations, which may be developed using Viewlet technology or similar, to describe the use of CAD and design tools. Furthermore, work towards a fully integrated online quizzing regime is being developed, as well as new interactive presentations for the example assignments.

It is noteworthy that, though technological advancement and the implementation of active learning methods may seem unrelated, in actual fact, they are closely integrated as one facilitates the other. For example, cooperative learning is enhanced by the use of discussion boards, chat rooms and email, since students working together on a project often reside in different emirates and require technological means of communication during weekends for progress to be made on their work. The use of Viewlets is also a good example, where active learning is made possible through the availability of a computer-based tool to facilitate independent study. This is further demonstrated by the fact that students who may be absent from class on a particular day, for instance due to illness, can access the class material through BlackBoard (PowerPoint shows, MS Word files, etc) and related Viewlet materials, at the same time as students who are present in class, and are able to communicate with the instructor in real time in a remote way.

Conclusion

This paper has highlighted a range of ideas which will need further analysis to fully appreciate the changes that are occurring in engineering education regionally. It has highlighted cultural issues, linguistic issues, moral issues, technological issues and learning issues. Furthermore, the paper has discussed these topics by highlighting in detail three key aspects of tuition in engineering, and focused on the case of teaching Design and Computer Aided Design, as these taught courses encompass a model for all the issues raised. First, the

importance of examining and understanding active learning and how this can make a positive contribution to students in the Arabian Gulf region was examined. Secondly, I analyzed the use of new technology in facilitating such learning through the use of NetOp instead of the whiteboard, "Viewlets" for online display of the use of relevant software, remote office hours concurrently available with traditional office hours, communication through e-mails and chat being encouraged, student-student collaboration to promote communication skills and student interaction with interactive course materials. All these technologies and more can help to promote independent learning. Finally, the paper examined the Design and Engineering Graphics courses and their latest developments within the dialectic of active learning and new technology. The paper has further demonstrated the importance of an integrated approach in the implementation of new technologies into the classroom environment and simultaneously, and very consciously, the development and implementation of active learning methods to appreciate and enhance the dynamics of instruction. In an age where, through technology, engineering instruction has changed so rapidly and in an environment rich in cultural and linguistic challenges, it is refreshing to know that through the application of tried and tested methodologies, a paradigm shift in the learning experience can successfully be promoted.

The Author's personal perspective is that significant progress remains to be made, not only at UAE University, but across the region in order for the marriage of new technology and reformation in educational pedagogy to work in harmony to the mutual benefit of both students and academic staff. However, the advancement that has been achieved thus far into the new millennium is a testimony to the strategic vision of the nation as well as an indication of the growing relevance the UAE will play regionally and internationally in the coming years, through highly educated participants in the developing knowledge economy.

About the author

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References

Al-Maeena, K. (1997). Where is the Quality in Arab Education? *Arab News (17th June, 1997)*. Jeddah, Saudi Arabia.

Byron-Pipes, R. and Wilson, J. (1996). A Multimedia Model for Undergraduate Education. *Technology in Society, 18*(3): 387-401.

Leake, J., Bynom, T., Clery, D. and Aston, S. (2000). Team Teaching: A Way Forward for ESP. *English Teaching Forum 39*(1): 38-42.

McGregor, D. (1960). *The Human Side of Enterprise.* New York: McGraw-Hill.

McKenzie, J. (1999). Scoring High with New Information Technologies. *From Now On: The Educational Technology Journal, 8*(7). Retrieved 11 June, 2006 from http://www.fno.org/apr99/scoring.html

Oakley, B. (2002). It Takes Two to Tango: How 'Good' Students Enable Problematic Behavior in Teams. *Journal of Student Centered Learning, 1*(1): 19-27.

Perkins, D. (2003). *King Arthur's Round Table: How Collaborative Conversations Create Smart Organizations*. New York: Wiley.

Randeree, K. (2002). The Internet as a Tool for Effectively Understanding the Engineering Profession. *Proceedings of the 6th Saudi Technical Conference*. Dhahran, Kingdom of Saudi Arabia: King Fahd University of Petroleum and Minerals.

Roland Christensen, C., Garvin, D. A., and Sweet, A. (1991). *Education For Judgment: The Artistry Of Discussion Leadership*. Cambridge, MA: Harvard Business School.

Seymour, E. (2001). Tracking the processes of change in US undergraduate education in science, mathematics, engineering, and technology. *Science Education, 86*(1): 79-105.

Wood, J.C., Wood, M.C., F. W. Taylor (2002). *Critical Evaluations in Business and Management*. London: Routledge.