Incorporating a variety of assessment tools in a web-based postgraduate course developed for practicing engineers

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***Abstract**: Practicing engineers seek to enhance their careers through upgrading skills. Coursework based postgraduate programs are being offered by various institutions targeting these engineers. While face-to-face lectures are feasible in certain circumstances, these courses are ideally suited for web-based delivery, due its flexibility in learning and teaching. Due to industry driven demand, a graduate certificate program was introduced recently by the Faculty. One of the major challenges faced in the design and delivery of courses within this program is the need to cater for a diverse student cohort with varying industry experience. The experiences of the author in developing two courses this graduate program is be discussed in this paper. These courses have been successfully delivered employing a variety of assessment tools. These include summative assessments such as a minor assignment, online discussions and quizzes and a major design project. Designing a course with a variety of assessment tools not only enhances the student learning experience, but also provides an enjoyable challenge for the lecturer.*

Introduction

Many practicing professionals are now more conscious in updating their knowledge and in the improvement of their competence to keep abreast with the fast changing technology and high competition in today's labour market. At the same time, continuous professional development (CPD) is becoming mandatory in most professional organizations. CPD embraces the idea that individuals aim for continuous improvement in their professional skills and knowledge, beyond the basic training initially required to carry out the job (Gray, 2005). This view is shared by engineers and engineering technology professionals, as well as by a significant majority of their employers. For practicing engineers in Australia, evidence of participation in continuing professional development is required to attain and maintain registration as a Chartered Professional Engineer (EA, 2010). In the recent survey funded by Government of Canada's Sector Council Program, it was found out that the engineering profession lag somewhat behind the majority of regulated professions in updating their technical skills. The results of the survey showed that practicing engineers undertook only approximately four days of CPD per year or equivalent of just under 2% of their paid time. For these working engineers, as it is often difficult to find a convenient time to attend CPD. Thus, the survey suggests, that continuing professional development policies should be flexible in identifying the acceptable modalities for continuing professional development. In another study conducted by Oladiran (1999), majority of the practicing engineers from developing countries have not been involved in CPD due to non-availability of development courses.

Many academic institutions and professional organizations are now offering coursework based postgraduate programs targeting these practicing engineers. However, these various institutions and organizations still find it very difficult to challenge the existing orthodoxies of coursework based program teaching within their current institutional structures. The best that they could offer is organizing the classes during weekends and evenings. For working engineers, attending a postgraduate program in a classroom environment is difficult as it means time loss to their employers as well as to their family. This is more difficult for practicing engineers working in remote areas as travelling to attend classes alone entail too much time and is very costly.

The need for an online postgraduate course in structural engineering

Several practicing engineers sometimes discover that there were certain aspects of their profession that were not covered during their undergraduate studies. Similarly, it is sometimes difficult for engineers who have been in practice for a long time to be current with modern developments in technology and available tools. There is also a continuous social and economic change resulting to many technological developments and creating the demand for new technical skill requirements and competencies. For earlier graduate engineers, this means that they may become less competitive and unable to define tasks to increase quality and productivity. For the construction industry, these changes will result in shortages in skilled labour in these areas. While there are a number of avenues where practicing engineers can update their technical skills and knowledge on new technological advancements through journal articles, short courses, conferences, books, and videotapes, this information are mostly technical in nature and could be difficult for them to comprehend and relate in the real world applications.

An example of these new advances in structural engineering is the development and application of fibre composite materials in civil infrastructure. Despite the strong indications of the potential of these materials, fibre composites continue to be slow in penetrating the mainstream civil engineering marketplace. The main reason for this continued lack of penetration and growth has been that civil engineers for the most part are not sufficiently trained to design and specify fibre composite materials for construction (Mirmiran et al 2003). Training, education, skills and knowledge development in a proper venue is therefore important to fill the industry's needs and shortages in this leading edge technology and sustainability. However, proper design of the course is important and effective delivery methods should be considered in order to cater the working engineers.

In 2002, Japan has started to provide learning contents for engineers named "Web Learning Plaza" (Ishimasa et al., 2003). This e-learning environment enabled the practicing engineers to learn their special field and gain professional developments, at any time and at any place, through the web. However, this electronic learning environment is available in Japanese language only. In 2007, the Faculty took the initial steps in offering a postgraduate course with advanced technical contents for practicing engineers. The Faculty has offered for the first time the Postgraduate Certificate in Advanced Structural Engineering Design program. This program presents the practising engineers employed in the profession the opportunity to both broaden and upgrade their skills in the area of structural engineering. This is a four course postgraduate certificate provides a recognised and accredited tertiary qualification. This paper will focus on the experiences of the author in developing and delivering the two courses in this postgraduate program, the ENG8802-Mechanics and Technology of Fibre Composites and ENG8803-Advanced Prestressed Concrete. Evaluation on the effectiveness of the diverse assessment strategies of courses delivered in an online environment from a student learning perspective is also discussed.

Design and delivery of ENG8802 and ENG8803

The technical nature of the topic and the lack of a University-accredited program in Australia on courses with advanced technical contents have lead to the difficulty of incorporating it in an undergraduate course. The option is to offer this in postgraduate programs or for continuing professional development for several engineers. Fibre composites are rarely covered in their undergraduate curriculum for engineers. While basic principles of prestressed concrete are covered at undergraduate level, it would be impossible to expect a graduate to design a prestressed bridge or a structure, without further training within the industry or through advanced professional courses.

Course content

These postgraduate courses are delivered and assessed through a series of taught modules encompassing relevant subject matter which aims to diversify and maintain currency of a practicing engineers in his/her profession. At the end of the course, students are expected to demonstrate their knowledge on these advanced technical courses, and apply appropriately this advanced knowledge in designing structures.

The course on ENG8803 – Mechanics and Technology of Fibre Composites aims to address the need for improved understanding of composites within the civil engineering context. This course is intended for practicing civil and structural engineers who need to acquaint themselves in the principles, recent structural design techniques and the latest utilisation of the advanced composite materials in the civil infrastructure. The foundation of this course is based on the study book on fibre composites authored by Van Erp (2008). This is the first web-based course offered in Australia on fibre composites making use of the technical expertise of staff at USQ in this particular area, through the pioneering research and development work. In 2009, this course was also offered as an elective course for undergraduate engineering students, who are in their last year in the university.

ENG8802- Advanced Prestressed Concrete focuses on the latest applications of prestressed concrete to a wide range of structures, and their potential applications. Most curriculum covers the basics of prestressed concrete at undergraduate level, but do not cover in-depth on the design and detail of prestressed concrete structures. Recent advancements such as external post-tensioning is another area that design engineers need exposure in Australia. Based on the authors extensive experience in this prestressed concrete, ENG8802 was developed focusing on design and construction issues. This course uses the books on prestressed concrete written by Gilbert and Mickleborough (1990) or Lin and Burns (1981). Table 1 and 2 list the study modules for these online postgraduate courses.

Table 1: Course content of ENG8803

Module	Topics
1	The application of composite materials in civil engineering structures
2	Polymer matrix materials for civil and structural engineers
3	Fibre reinforcement for composite materials
4	Composite material behaviour
5	Structural design of fibre composites in civil engineering environment
6	Lamina design properties
7	Flexural behavior and robustness
8	Determination of characteristic lamina properties by physical testing
9	Durability of fibre composites

Table 2: Course content of ENG8802

Module	Topics
1	Principles of prestressing concrete
2	Design of prestressed beams in flexure
3	Design for shear, bond and bearing
4	Deflections
5	Losses of prestress
6	End anchorages
7	Continuous beams

Design methods and delivery

For postgraduate students and professionals, the course delivery can become an issue. Face to face delivery may not be feasible and sustainability of the course can become a problem. With the experience and expertise of delivering external and online courses, web-based delivery was considered the best option for these two courses. It could provide the convenience and flexibility for students to complete the course at their own pace at a time and place that fits in with their other commitments as most are already employed in some capacity. The ENG8803 is being offered every first semester that runs from the beginning of March to end of July while ENG8802 starts from mid of July and ends in the last week of November. These courses are entirely web-based using the Moodle system. The study materials for these courses are regularly uploaded through the course homepage on the StudyDesk, the portal that host the Moddle learning management system.

Assessment

Table 3 summarizes the assessment criteria for the ENG8803 and ENG8802. The table shows that during in 2008, the assessment for ENG8803 only includes 2 major assignments: Assignment 1 which covers modules 1-4 and Assignment 2 which covers modules 5-9. In 2009, online quizzes and discussion are introduced and included in the assessment criteria. For ENG8802, the assessment is composed of minor assignment, major assignment, online quizzes and online discussions. However, the weightings for quizzes and discussions in 2008 were interchanged in 2009. In every assignment, each student is given a different set of design parameters to avoid any collusion and uniqueness of the answer. Submission of all these assignments was a compulsory requirement for the subject assessment. As per the course specifications, students are required to achieve at least 50% overall in order to eligible for a pass in the course.

Table 3: Assessment criteria and weighting for the online postgraduate courses

Criteria	ENG8803		ENG8802	
	2008	2009	2008	2009
Assignment 1	40	30	25	25
Assignment 2	60	50	50	50
Quizzes	0	10	15	10
On-line discussion	0	10	10	15
Total	100	100	100	100

E-learning innovations

The sustainability due to low enrolment rate is always a concern for newly introduced engineering courses. Innovative teaching methods and new learning resource should therefore be developed to increase course attractiveness and produce better educational outcomes. In the delivery of ENG8802 and ENG8803, several innovative teaching techniques are implemented and a number of developed resources are made available to enhance student's learning. The key innovations in these courses are delivery of online lectures, video enhancements of testing and manufacturing processes, electronic assignment submission and marking. More familiar tools such as the online discussions and quizzes are also discussed in this section.

Guest lectures

The different study modules in ENG8802 are uploaded on the StudyDesk. This is supplemented with Breeze presentations on each topic module. These web-based presentations are converted PowerPoint presentations on each study module with narration prepared by the author.

For ENG8803, selected lectures and papers presented in workshops and conferences on fibre composites were uploaded in the StudyDesk. These were made available to the student to increase their awareness and understanding of the technological progress in Australia and overseas on fibre composites in civil infrastructure. Video and PowerPoint presentations and some of the papers presented in the International workshop on Fibre Composites in Civil Infrastructure held in USQ Toowoomba in December 2008 and the Composites Australia Conference and Trade Show in March 2009 were recorded and uploaded. Such provision allowed student to learn directly from experienced engineers in the industry. These are accomplished with the assistance of the professional services of video and audio recording as well as multi-media services at USQ through its Distance and e-Learning Centre (DeC).

Electronic submission and marking

Electronic assignment submission through electronic submission boxes is encouraged for all assignments. Similarly, Tablet PC's are used for marking and providing electronic feedback for assessment items. This enabled the markers to provide feedback in the electronic environment and in a timely manner. Results of the assignments were quickly returned to all students interstate and even, overseas. This is a great accomplishment compared with postal delivery processes as turnaround times of three weeks or more may be experienced in some cases.

Online videos

In the delivery of the ENG8803, video clips on manufacturing and testing of fibre composite and polymer materials are also uploaded on the StudyDesk. These instructional videos were developed by CEEFC and PARTEC Institute, with support from the Australian Flexible Learning Framework. This provides a more enhanced course delivery on fibre composites in a flexible learning environment.

Online quizzes

Online quizzes which are composed of formative assessment items are set-up on the StudyDesk to enhance student's learning. Most are multiple-choice type questions with a few fill in the blanks to test the student's understanding on each module of the course. For Eng8803, 5 sets of quizzes are introduced in 2009 while for ENG8802, the initial 2 sets of quizzes prepared in 2008 was increased to 5 in 2009. Students are given unlimited attempts to answer these quizzes but only their first attempt for each set of quiz is marked. While these online quizzes are available throughout the semester, students are encouraged to attempt as soon as they are released as deadline is set for the first attempt.

Online discussions

Electronic discussion facilities in the StudyDesk are used extensively for communication amongst students and lecturer. Online discussions (but not marked) on each topic module are conducted providing an opportunity to discuss pertinent issues with flexibility in asynchronous mode. In addition, assessed discussion topics covering selected areas on the course content are introduced periodically throughout the semester. The participation of the students on these online discussion topics is assessed based on the quality and quantity of their contribution. The assessed online discussion topics are set-up differently for ENG8803 and ENG8802. In ENG8803, the assessed online discussion is designed such that students have to give their comments and answer first on the relevant topic before they can see others contribution. In ENG8802, a standard forum discussion, where students can see and comment on each discussion posted by all students, is set-up at the end of each module for the students to demonstrate their understanding on some information relevant to each study modules and share their own knowledge on how these topics relate to actual design and applications of prestressed concrete structures.

Student performance in two years

The performance of students in ENG8802 and ENG8803 for 2 years (2008 and 2009) is discussed in the succeeding sections. The students enrolled in the course from different States and overseas are summarised in Table 4.

Table 4: Locations of students

Location	ENG8802		ENG8803	
	2008	2009	2008	2009
New South Wales	1	2	1	2
Queensland	4	5	3	7
Tasmania	0	0	0	1
Victoria	2	0	0	2
South Australia	0	1	1	1
Western Australia	0	2	1	1
Overseas	1	1	0	1
Total	**8**	**11**	**7**	**15**

The results show that there is a reasonable increase in the number of students from 2008 to 2009 for both online postgraduate courses. For ENG8803, from only 7 students in 2008, the number increased to 15 (10 postgraduates and 5 undergraduates) in 2009 showing the increase in interest in this area while 3 more students took ENG8802 in 2009 than in 2008. The flexibility of teaching delivery resulted to at least 1 student enrolled from each state in Australia in 2009. On the same year, a student from the US took both ENG8803 and ENG8802. The results of the survey show that most of the students who took the course are working in the construction and consulting industries with at least 2

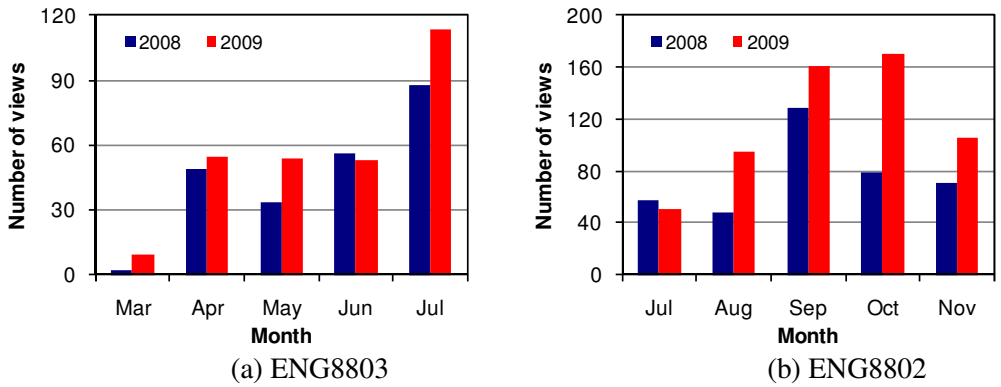
years working experience. For Eng8803, most of students indicated that they have poor knowledge in fibre composites while most of the students who took ENG8802 said that they have a neutral knowledge in prestressed concrete. The main reason for students taking the ENG8803 course is to have a better understanding on fibre composite materials and to effectively use this material in real world situations. Most of the students who took the ENG8802 course aim to enhance their capabilities in designing structures and some signified their intention to shift their career to designing prestressed concrete structures

Student participation

The Figure 1 shows a normalized value of the level of participation of students (total number of participation per student) for ENG8802 and ENG8803 during the course of the semester. It can be seen from the figure that the students logged in the StudyDesk the least in March. During this month, the students are just starting to familiarize themselves with the StudyDesk and the course. As the course progresses, students logged in the Study-Desk and studied the course modules more often. In 2008, the students logged in the StudyDesk the most during the months of June and July. It is important to note that Assignments 1 and 2, which are the only basis for assessment, are due on these months. In 2009, the level of participation is at its most in July when Assignment 2 is due. Interestingly, the level of participation by students remains the same for the months of April to June. This is due to the introduction of the quizzes, online discussions, guest lecture and online videos which keeps the level of interest on the course.

Similar trend was observed in ENG8802 where there is an obvious increase in student's participation from 2008 to 2009. This high level of interaction could be due to the increase in the number of marked quizzes from 2 to 5 to be attempted. Similarly, one possible reason for this increase in the level of participation is the increase in the weighting of assessed online discussions. In general, students logged in to the StudyDesk more frequently in 2009 than in 2008.

Figure 2a shows the number of times the students viewed each study module for ENG8803. The figure shows that the most read topic is the review on developments and application of fibre composites in civil infrastructure. There is also a high level of interest in the under-standing the behaviour of fibre composite materials and designing structures from these advanced materials. This is compatible with the result of the survey on the interest of students taking the course. How-ever, the topic on durability seems to be the least interesting. Figure 2b shows the number of posts made by each student on the different discussion topics and the number attempts made for each quiz. All of the students shared their view and opinions on every discussion topics posted. Similarly, all the students, except for one, tried answering the online quizzes. Even though only the first attempt on the online quizzes is being marked, some of the students have tried answering the online quizzes more than once. Similarly, each student viewed the all the guest lectures and online videos at least once during the course.

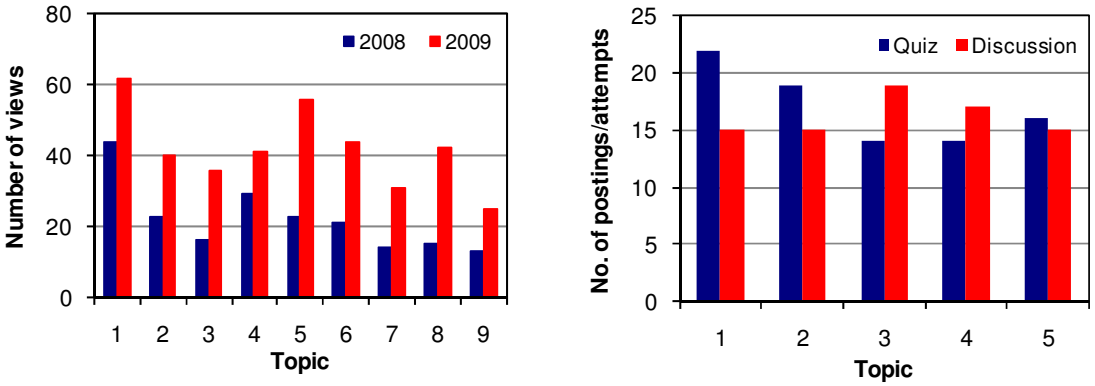


(a) ENG8803 (b) ENG8802

Figure 1: Participation of students to the online postgraduate courses

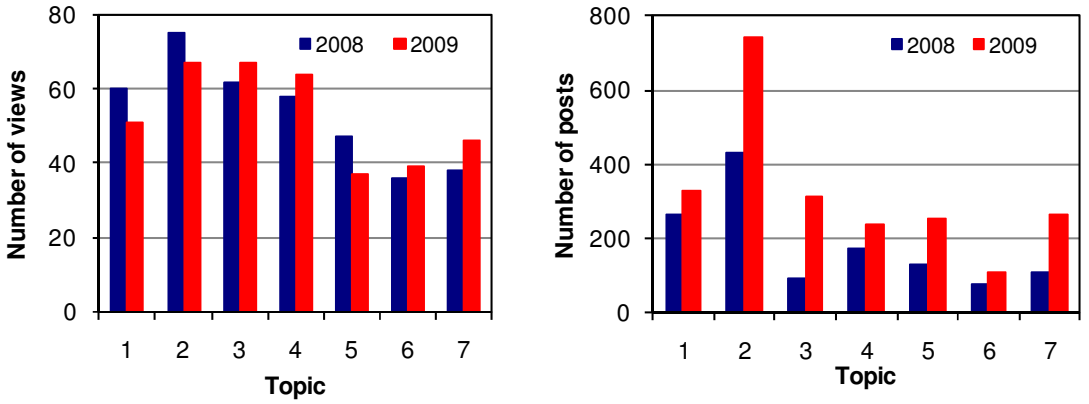
Figures 3a and 3b compare the number of views and posts of students for each study module in ENG8802, respectively. It can be seen from Figure 4a that there is no much difference on the number students studied the course between 2008 and 2009. It can also be seen that students studied topic 2 the most in this subject. Interestingly, students are constantly studying each topic in 2009. This could

be due to development of quizzes in these areas which made the students gave equal attention to most of the study modules. Though there is no significant difference in the level of students studying the courses, there is a significant increase in the number of posts from students from 2008 to 2009 due to the increase in the weightings of the online discussions.



(a) Number of views per topic (b) Discussion posts and quiz attempts

Figure 2: Participation of students to ENG8803



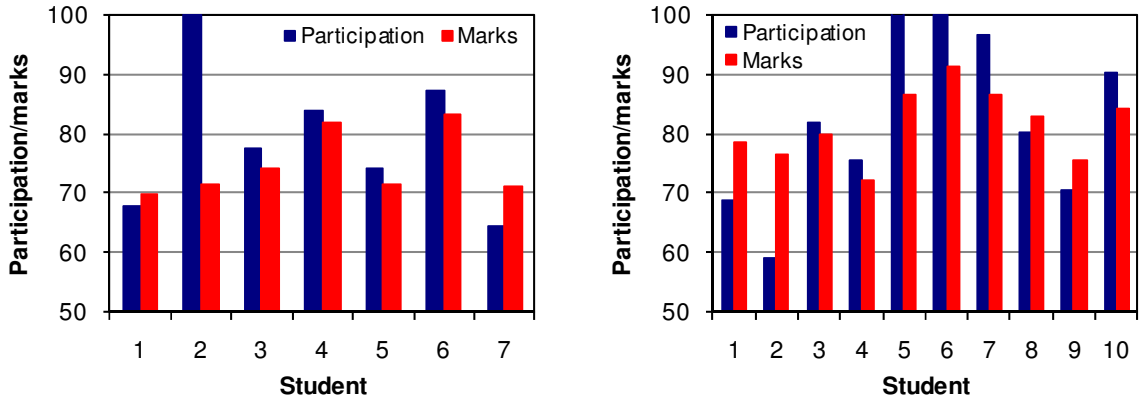
(a) Number of views per topic (b) Discussion posts

Figure 3: Participation of students to ENG8802

Student performance

Most of the students passed the course even though initial survey showed that majority of the students who took the course have little knowledge on the different study modules of the online courses, especially on fibre composites. This result shows the effectiveness of the delivery of the course.

Figures 4a and 4b show comparison of the level of participation and the raw marks of each student who took ENG8802 in 2008 and 2009, respectively. In these figures, the level of participation is normalised based on the student who had the highest level of participation. Similarly, students who failed in the course are not included in the comparison. The results show that, in most cases, the students who actively participate in the discussion got higher marks than those who are less active. This is more obvious in 2009 wherein the 3 most active students received the highest marks. Similarly, the high level of interest of students in the course due to the additional online quizzes and marked discussions resulted to higher marks to students as the average marks of students in 2009 is higher than in 2008. However, exception to this is noted in Figure 4(a) where one student who actively participated in the discussion got an overall lower mark compared to others. This was a result of getting performing poorly in the first assignment that had 25% weight. Similarly, from Figure 4(b) it can be seen there are variation of the level of participation especially in the range of 70-80% of the final grade. This can be attributed to their performance in the other two assignments, where some key elements have been not demonstrated.



(a) 2008 (b) 2009

Figure 4: Participation of students to the ENG8802

Conclusions

Practicing engineers are in need of knowledge and skills on new technological advancements in their professional field. However, they do not have the time to do so. The introduction of postgraduate courses with advanced technical content which are delivered entirely online at USQ made this possible. This provides the practicing engineers a flexible learning environment combined with development of innovative learning resource to continue their professional development. The experiences in the two years of offering of these online postgraduate courses showed that such courses with high level technical content could be effectively designed and delivered via an online environment. However, these courses need to be continuously updated in order to provide the recent developments in the industry as well to make these courses sustainable, relevant and competitive.

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