AC 2008-515: CRAFTING ONLINE EXAMS IN ENGINEERING AND TECHNOLOGY: LATEST CHALLENGES, METHODOLOGIES, AND TRENDS

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Crafting Online Exams in Engineering and Technology: Latest Challenges, Methodologies, and Trends

Abstract. In recent years distance education and learning have emerged as a popular method of instructional delivery in engineering and technology-related fields. Many faculties of engineering and technology may found themselves teaching online classes or thinking about teaching one. In this process, crafting and preparation of online exams without sacrificing the educational quality and exam security is a crucial issue to the faculty. Psychological setbacks and barriers among engineering students also add another concern for the faculty teaching in a distance education environment, i.e., students may have fears of losing partial credit in an online multiple-choice exam. The asynchronous and economical advantages of distance education and learning that make offering and taking them very popular force the profession to re-examine and re-engineer some of these exam-related issues.

In this paper we discuss issues as they relate to crafting online exams for the distance learning students in engineering and technology. More specifically, we discuss one major theme: how should faculty craft and design online exams for students studying in engineering and technology-related fields? We use some accurate but crude empirical data and evaluation methodologies to draw our conclusions. The data used are collected from more recent sample courses that have been taught by the authors over the last five years. This facilitates the evaluation of the latest challenges, development of new methodologies, and monitoring the current trends.

Introduction

Prior to the availability of computer and software technology used routinely today, "distance learning" was referred to as an individualized mode of learning only available through correspondence. Today, "distance learning" and interchangeably used "distance education" are commonly referred to as a field of education that investigates and examines pedagogical technologies and the design of advanced instructional systems used to deliver education remotely to students who are not physically present in the classroom. Present technology and the accessibility of the internet have made distance learning much more viable, and it has evolved from traditional ways to robust, more efficient, and more convenient for students and instructors. Online teaching and learning is progressively regarded as a means of increasing flexibility and robustness of delivery to provide for greater student access to, and control over, their learning whether they are studying on-campus or in distance mode, or offshore[1, 2, 3].

Current technologies allow instructors and students to communicate asynchronously, at times and locations of their own choosing, by exchanging printed and or electronic information. New technology, such as Backboard™, provides a more efficient and robust management system for remote classrooms. With this new trend in distance learning and education, in recent years distance education and learning have emerged as a popular method of instructional delivery in engineering and technology-related fields. Many faculties of engineering and technology may find themselves teaching online classes or thinking about teaching one. In this process, crafting and preparing online exams without sacrificing the educational quality and exam security is a

crucial issue to the faculty. This process can be quite challenging at times particularly for the faculty that do not have any prior experience with teaching online courses. Psychological setbacks and barriers among engineering students also add another concern for the faculty teaching in a distance education environment, i.e., students may have fears of losing partial credit in an online multiple-choice exam. The asynchronous and economical advantages of distance education and learning that make offering and taking them very popular force the profession to re-examine, re-organize, and re-engineer some of the exam-related issues that otherwise don't exist.

The use of online-based, "open book, open mind" approach is being recognized in the literature as a potential method of examination for distance courses in the faculties of engineering, science, and technology[1,3]. Faculty may have to develop new methodologies, and structure or restructure their course differently to accommodate and facilitate the effectiveness of online examination methods. Some very recent studies documented the practicality and effectiveness of distance learning methodologies[3]. Results from an early study of the desirability and feasibility of using distance learning indicated that this teaching and methodology has a useful role in distance learning[4]. The case for employing project-based learning methods as opposed to more traditional teaching methods, where the learning path follows a carefully predetermined structure, has been argued elsewhere[3].

In this paper we discuss issues as they relate to crafting online exams for the distance learning students in engineering and technology. More specifically, we focus our discussion on one major theme: how should faculty craft and design online exams for students studying in engineering and technology-related fields? We use some accurate but crude empirical data and evaluation methodologies to draw our conclusions. The data used are collected by the authors from more recent sample courses that have been taught by the authors over the last five years. This facilitates the evaluation of the latest challenges, development of new methodologies, and monitoring the current trends.

Faculty Concerns

Learning is seen as essentially a social process, requiring communication among learner, teacher and others. This social process cannot effectively be replaced by technology, although technology may facilitate it[5]. While faculties are concerned with students' learning, outcome, and assessment, based on our personal experience, we observe that students are often concerned with their grades. Rightly so, but in some instances, students may take this too far and transform the reputation of a course from a learning-centered course to a grading-centered focus.

Recognizing that grades can be used as an important assessment tools in many instances, it is essential to ensure the impartiality of the exam and thus increasing the effectiveness of this important assessment tool. This is particularly applicable in an online examination environment in which granting partial credit is neither practical nor manageable. How can a faculty ensure that a student's knowledge about the subject matter is measured by an online examination if the entire knowledge of the student about the subject matter can not be measured? Most online exams consist of either multiple choice, true/false, or short answer type of questions. In some online exams the combinations of the questions and their different types are used. In each case,

there are variations in the responses. However, the inability of granting partial credit in an online examination environment may indicate false assessment measures of the students' progress in the course. Nevertheless, we find that the following concerns challenge the faculty on numerous occasions and are more common in crafting online examinations for the engineering and technology-related courses:

1. Examination Security: In an online "open book, open mind" examination environment where there is no in-person or remote visual examination monitoring, the exams shall be crafted as such to prevent any kind of plagiarism or illegal use of the available materials. Several such cases are reported by Colwell and Jenks in 2005[6]. Due to the difficulty of controlling the online examination environment against plagiarism, we found that the students should be tested more on the concepts rather than the material that can be easily plagiarized. This may work well for some courses. However, this is not an easy task for courses that involve engineering design that heavily relied on calculations. To reduce the likelihood of plagiarism, we suggest and used a contract similar of that presented in Colwell and Jenks [6]. Depending on the course under consideration, we also use random question/problem generators in WebCT™ and Blackboard™. Basically, there in no easy way around this issue. We feel that this is one of the trade/offs of distance learning. However, like any other examination environment, there should be no concern about the exam security if the students are honest about their learning. Honesty is the best policy to enforce that fairly eliminates this issue.

2. Interactivity: Some faculty feels that they should be available during the examination period. Some student suggests to us informally that they feel that they perform better if taking "live" exams as opposed to "online" exams. If that is the case, the availability of the faculty is essential in case students have questions regarding the exam content and material. The faculty may desire to let the students know in advance about the exam availability period and his/her availability. Faculty can remotely contacted by the students via emails, messengers, and telephones while taking the examination.

3. Equity: Some faculty is concerned with the level of difficulty of questions for different students. They believe that all students taking the same course at the same time shall receive exams of the same level of difficulty. Faculty may feel that this is just and equitable. In an online examination environment, we propose "guided grouping of the questions" in which we divide the questions according to their level of difficulty. We then use questions at random for the same examination for the same course. This is applicable to cases in which we use random question generation functions in the online course management systems. Faculty may have to go through a period of "trial and error" before they can master this method. It also requires more time and dedication in crafting online exams for the courses with less available resources for the faculty.

4. "Hands-on" Demonstration of Concept: In some online laboratory environments some faculty would like to see their students to demonstrate their understanding of the concept. This is not an easy task for online students that take the course remotely. We recommend utilizing screen-capturing software in which every movement of the cursor on the computer screen can be captured and traced back. Our experience with experimenting with screen-capturing software at

this stage is a work in progress. We should be able to provide more information of our experimental approach in the near future.

5. Team-workability Assessment: Group performance and team-workability skills are important tasks for the engineering and technology students to learn while they are still at school. In an online course environment, there should be methods of assessment for students' workability and performance in teams. We assess students' performance in teams by methods used by Mehrabian et. al[3] where they described their experiences for a senior design project course. In this case, students worked remotely in teams. In some case the students (team members) lived as far as 200 miles apart from each other.

Exam Methodologies

Online learning systems allow faculty to design exams with different types of questions including, but not limited to multiple choice, true/false, matching, short question, paragraph, and calculations. Another mechanism that is helpful to the faculty is the ability to set up the online learning system to select randomly sets of questions for the same online examination for the students. To use this mechanism, the faculty should have more than the minimum number of examination questions in the question's database. The system can be set up to allow students to take the examination during a given time window and a specific exam period. We experiment with different exam periods, from 2 hours up to 48 hours, to accommodate many students that are also full-time working adults. This is particularly applicable in engineering technology courses. Another good feature is the ability to set the system as such to allow students to take the same exam multiple number of times, or only one time. If the faculty desires to test students on the understanding of the concepts, less accessibility of the students to notes and books is perhaps desirable. To be able to ensure the integrity of online exams, one issue of concern to faculty is the ability to adjust exam time in such a way that students won't be able to use their class notes, text book, etc. to answer the online exam questions.

In engineering and technology, many of the examinations include graphic-based questions. The learning systems mentioned above may not be capable yet of allowing faculty to design that type of examination questions. To compensate for this present shortcoming feature, we think graphic-based exam questions can be designed in such a way that students can work on in groups using, for example, the capability of Autodesk® AutoCAD of allowing collaborative design. The contribution and input of every member in a group can be assessed and graded as all activities of given group of students at time stamped. In a course taught by the authors, student groups working different term assignments were assigned discussion space that is only accessible by the group members. No one else has access to that discussion space, but the instructor. Browsing individual groups' discussion spaces can give faculty some indication assessment of the performance and contributions of group members. We believe these discussion spaces can help providing faculty with some guidelines for preparing online exams.

Some Preliminary Data

Online examinations maybe viewed as measures of students' learning success and effectiveness in distance learning courses. The authors taught some same course in different semesters using

different modes of instructions of synchronous and asynchronous. We think that some preliminary assessment data and their comparisons of the outcomes of these courses taught using different modes are worth presenting here. The following data shown in Table 1 is a comparison between the outcomes of these courses taught by the authors offered at distance and live modes in 2005, 2006, and 2007.

We note that when a course is offered in two different modes in the same semester, the "live" students, taking the class synchronously, tend to have access to the course materials available online. This data is presented for the two sections taught by the same professor. From this data, "live" students seem to have performed better than those who are taking the course at "distance" only. It seems that students who have more than one method of learning are more likely to succeed. This is a work in progress and more information will become available as we complete our assessment of students progress and success in online versus live courses.

Course No./Semester	Live section	Distance Section
1/ Spring 2005	15 out of 18 passed the course	8 out of 14 passed the course
1/ Spring 2006	13 out of 16 passed the course	10 out of 15 passed the course
2/ Fall 2005	29 out of 30 passed the course	27 out of 30 passed the course
2/ Fall 2006	25 out of 25 passed the course	23 out of 25 passed the course
2/ Fall 2007	23 out of 23 passed the course	21 out of 23 passed the course

Table 1: Preliminary Data on the Same Courses Taught Via Live and Distance Modes

Summary and Conclusion

In recent years distance education and learning have emerged as a popular method of instructional delivery in engineering and technology-related fields. Many faculties of engineering and technology may found themselves teaching online classes or thinking about teaching one. In this process, crafting and preparation of online exams without sacrificing the educational quality and exam security is a crucial issue. Psychological setbacks and barriers among engineering students also add another concern for the faculty teaching in a distance education environment, i.e., students may have fears of losing partial credit in an online multiple-choice exam. The asynchronous and economical advantages of distance education and learning that make offering and taking them very popular force the profession to re-examine and re-engineer some of these exam-related issues.

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