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A Comparison of Student Performance in an Online with traditional Based Entry Level Engineering Course

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Abstract

Web technology offers a diverse set of possible innovations to the traditional teaching process. To assess the effectiveness of online learning in entry-level engineering courses, students' performances in an online and traditional version of the same course were conducted. In the online class, students have the opportunity to learn independently from anywhere at any time. The traditional classroom incorporates characteristics of both the traditional and online classroom settings.

The *Introduction to Engineering* course is the students' first exposure to engineering education and probably their first meaningful design experience. It starts with engineering applications and concepts in problem solving, and ends with introduction to design.

The student performance, student satisfaction, and instructor experiences were compared in the two class formats. In addition, the study documented the benefits and limitations of the two delivery alternatives. The students' perception of the instructor and the course with respect to content and delivery were evaluated. The students' comparative perceptions of their experiences within the online course versus a traditional course were also analyzed in the survey. Student suggestions for improvement of the course were also collected

The results show that students appreciated the fact that online courses provide them with convenience and flexibility, self-paced learning, and the opportunity to earn credit while not on campus. The students found the greatest drawback of online courses to be the ease with which one can fall behind, with a distant second being slow internet connections that affected ease of course material access, followed by the lack of student-teacher interaction. The students did not consider the online course to be easier than the traditional course, nor did they find the intellectual challenge to be less than in a traditional course, but 80% of the online students reported that they would recommend this Online delivered course to other students while 100%

of the traditional students would recommend the course to other students. It is clear that the course delivery, support, and the student's prior mastery of the Internet contributed to the satisfaction levels.

Introduction

Online-based course delivery has become an attractive option for expanding its reach to new students and to facilitate the scheduling of existing students. During a recent academic semester (spring' 03), the students at the University of New Haven (UNH) had the opportunity to enroll in such a course. The initial preparation for the online class was time consuming because of the amount of materials made available to the students. It has also been found from experience that it takes much more time to teach and administer Online courses. Other Online course developers agree that teaching and maintaining a Online course takes a considerable amount of time [4]. However, the time is well spent since the material developed in the Online courses can also be used in the regular classroom. Student satisfaction is about the same in the traditional course and the online courses.

Furthermore, the composition of the student population at UNH is more representative of those who might be interested in enrolling in Online-based classes. Many of the students in UNH work full or part-time and attend classes at night. Intuitively, it would seem that Online delivered classes would be very attractive to this demographic group. Thus, this study may be particularly useful for other institutions in similar situations.

ES 107, *Introduction to Engineering*, is a three semester-hour course. It provides an introduction to the engineering profession, to engineering problem solving, to design and to various software applications that are used throughout the engineering curriculum, including Excel and PowerPoint. The course is required for all freshman-engineering students and a large number of non-engineering majors at the University of New Haven take it as a scientific methodology elective. Consequently, approximately 200 undergraduate students annually take the course in sections containing approximately 25 students. There is a relatively even mixture of sophomore, junior and senior students that enroll in the class. The pre-requisite is college algebra.

The motivation for teaching Introduction to Engineering in an online format arose from three considerations. First, the UNH Co-op program accommodates many students on co-op assignments across the New England area. Many of these students desire to take required courses while away on their co-op assignments. Second, the online course affords convenience for student with unusual schedules and for students who do not live close to campus. It provides these students with the opportunity to earn course credits without leaving their communities. Third, offering the course in a distance-based format provides local full-time and non-traditional students with an opportunity to enroll and participate in courses with added time flexibility.

The course is managed using Blackboard software. All course information, assignments, lectures, quizzes, emails, submission of materials, group discussions, etc., are conducted through this one

site. Blackboard is a software application that resides on a university server and is accessed on the computer through use of a web browser such as Internet Explorer or Netscape Navigator.

Students normally contact the instructor using email. The instructor checks his email regularly and tries to answer questions as quickly as possible. A "Discussion Board" is available in Blackboard for group discussions. The instructor posts a discussion topic each week and each student is required to participate in the discussion at least once per week. These responses are posted in Blackboard and can be seen by the entire class at any time. The quality of participation, questions, comments, and discussion are graded.

The purpose of this study is to compare the effectiveness of the two Online and traditional class formats, as well as to learn from the experience.

Course Format Description

The course offered is an undergraduate introductory course in Engineering. It is a fundamental course, and was selected for this reason. The same instructor taught the two sections. Both sections covered substantially the same material, and completed similar assignments.

Lecture notes are provided, assignments are given and collected, and quizzes are conducted all on a regular schedule via Blackboard. The conditions for taking quizzes were quite distinct for the two course formats. The tests were available for twenty-four hours on the test dates for the online course and administered in class for the traditional format section. Quizzes had a time limit that was designed to be sufficiently restrictive to prevent the students' answering questions by spending a lot of time looking up the material in the text. Students were only allowed one attempt for a quiz and had to complete it within the specified time limit.

The course formats were as follows:

- Online based section (online class): This section was offered almost exclusively on the web. The class met once at the end of the semester to present the final design projects. An optional brief meeting at the beginning of the semester was also held to go over the Blackboard tutorial and course syllabus similar to the ones in the traditional format, as well as for testing purposes. Course materials in the form of lecture notes, text-based supplementary materials, discussion groups, and testing were offered through the Internet. The course used Blackboard as the course delivery platform. Test questions were drawn from the same test bank used for the traditional section.

- Traditional section (Mixed Mode): A separate section of this course was offered using a mix of traditional and Online based delivery means. The class met regularly for lectures, assignments, and tests, while Blackboard was used to deliver course materials as well as conduct discussions and exams. Testing was accomplished via multiple-choice exams using questions selected by the instructor, and administered in class. The exams and assignments in this section

were duplicates of those used for the Online-based section. Students receive face-to-face interaction with the instructor and students while at the same time being exposed to Online-based learning paradigms such as virtual real-time information, pictures, streaming video and audio clips. Traditional approaches also extend to providing students with both "real" office hours and "virtual" office hours, working in both face-to-face teams and virtual teams.

Materials Available to Students

Available to online and traditional students were the syllabus, Power Point slides, class notes (lecture outlines), textbook publication website, and Internet resources. The online class was identical to the Traditional class except for the addition of discussion board assignments for the online students.

Requirements

Three tests were scheduled for the class along with homework assignments and a final design project. As part of their course grade, the online students only were required to post relevant materials on the bulletin board weekly. The tests and other work were almost identical in both sessions taught by the same instructor with minor variations in the exams. The honor system was used for the online section. However, to allow for flexibility, the tests were available for twenty-four hours on the test dates for the online course and administered in class for the traditional format section. Not having a centralized location for the online students to take the tests, students were allowed to use their textbook or any other resource during the test. This was the same for the traditional students.

Methodology

The sample consisted of 37 students enrolled in the two sections in spring 2003. The same instructor taught the two course sections studied, used the same text, similar assignments, and test questions. These common aspects allow for direct comparison.

The students were asked to complete a 27question survey designed to assess their satisfaction with the online and the traditional modes of course delivery. The student assessments evaluated the students' perception of the instructor and the course with respect to content and delivery. The assessment also evaluated the students' comparative perceptions of their experiences within the online course versus a traditional course. Student suggestions for improvement of the course were also collected. The response rate was 88%. Analysis was performed on the questions to test for differences between the online course and the traditional course. The number of students enrolled were 20 in the traditional course section, and 17 in the Online based course section. Most of the students were juniors.

Tools for Assessing Student Performance

The survey used in the study consisted of multiple-choice exams using questions developed by the instructor. The exams themselves covered the same topics and questions were drawn from the same test bank, thus helping direct exam-to-exam comparison. A direct comparison of the average of the other assignments scores (homework and projects) was also possible.

Student satisfaction was considered important for the long-term success of Online based course offerings. For this purpose a developed questionnaire addressing the specifics of the course offerings was administered to the students in the two course sections; the questionnaire included both objective and open-ended questions. The questionnaire was composed of questions addressing overall student satisfaction and satisfaction with the course format, student motivation for selecting a particular course format, and whether students were willing to enroll in a similar course in the future. The questionnaire used to elicit these responses was simple and did not include provisions for calculation of validity and reliability statistics.

Instructor experiences were also documented through discussion and anecdotal references. The goal was to document problems experienced, as well as potential solutions to them. Also instructor satisfaction with the course format and supporting materials were of interest.

Results and Analysis

Student Performance

Class performance was evaluated by comparing course work scores between the two classes using duplicate assignments, and as an aggregate using overall work averages. The goal was to determine if there were significant differences in student performance between classes.

A direct comparison of exam scores for three exams administered in the traditional and a Online based class was undertaken. As is evident from examining Table 1A, there is little difference between average exam scores. The analysis indicates that there is no significant difference between the exam scores. Although exam results are but one out of several criteria normally used in evaluating student performance, in this situation they serve as a readily available measure.

Course Section	Exam #1 Average	Exam #2 Average	Exam #3 Average
Traditional Class	74	77.5	68
Online based class	72.5	83	69

Table 1A: Average Exam Scores

Comparison of the average of the class average for both sections indicates no significant difference between assignment score averages. It appears from the data collected, that there was no significant difference in student performance, regardless of the class format. This is an encouraging result, and bodes well for the future of Online-based education.

As shown in table 1B, grades on average are a little higher for Online students as compared to the regular students. This result didn't come as a surprise. Some case studies support this observation [7]. This may be because many of the online students are generally working and may have more practical experience in the subject matter, and also may be studying more compared to the regular students. Motivation may be another factor for their performance being slightly higher than the regular students.

Work Assigned (Weight)	# of Points Traditional section	# of Points Online section
Participation (10%)	90	85
Quizzes (30%)	73	75
Homework (40%)	82	88
Final Design Project (20%)	80	83
Class Average (100%)	80	83
Overall GPA	2.6	3.25

Table 1B: Class Average

Student Satisfaction

Although student performance is an important measure of the success of a Online based curriculum, student satisfaction is important for the continued success of such a program. It was therefore important to gauge student feelings about the Online-based course. This was accomplished by asking the students how they felt about the course, as well as whether they might want to take a course offered in a similar format again. It was also of interest to ascertain the reason the students had selected a particular section and the attendant delivery format. Students were asked these questions in the questionnaire.

It was important to establish why students had enrolled in a particular section of this course. The assumption here was that students would select the Online-based section deliberately. As shown in Table 3, most students selected a given section of the course based on the time and place convenience for that section.

Online classes are different from traditional classes. What factor appealed to you most?	% Responses	
	Online based Class	**Traditional Class**
Working at my own speed and convenience	93%	61%
One-on-one interaction with the instructor.	20%	28%
Learning to use the Web for instructional purposes.	33%	22%
The wealth of information available to me	7%	22%
Discussion Board	13%	N/A

Table 3: Student Course Section Selection

Students were also asked if they were satisfied with the course. Table 4 shows the data collected from this question. Examination of the data show that students enrolled in the Online-based section were somewhat less satisfied with the course than the traditional students. This was confirmed through the use the same assessment survey. The data then, show evidence of different satisfaction levels due to differing course formats. It is quite likely, as will be discussed later, that problems encountered by students in the Online class may have had some impact on their satisfaction level.

Comparing this particular Internet-based course to traditional classroom-based lecture courses in all aspects (including the course structure, ready availability of course-content related materials, convenience or flexibility in learning regarding time and place, intellectual stimulation and the opportunity for active learning,, availability of instructor assistance, etc.), I think that this course is:	% Responses	
	Online based Class	**Traditional Class**
Much better	27%	39%
Better	13%	39%
About the same	40%	6%
Worse	13%	0%
Much worse	0%	0%
No opinion or do not understand the question		11%

The technology(ies) used in this course has been appropriate for course content.	% Responses	
	Online based Class	**Traditional Class**
Strongly agree	47%	50%
Agree	40%	50%
Fair	13%	0%
Disagree	0%	0%
Strongly disagree	0%	0%

Reasonableness of assigned work has been	% Responses	
	Online based Class	**Traditional Class**
Excellent	13%	28%
Very Good	47%	39%
Good	40%	28%
Fair	0%	6%
Poor	0%	0%

Relevance of activities and assignments to Learning Unit goals has been	% Responses	
	Online based Class	**Traditional Class**
Excellent	20%	39%
Very Good	27%	17%
Good	53%	33%
Fair	0%	11%
Poor	0%	0%

The amount of effort to succeed in the course has been	% Responses	
	Online based Class	**Traditional Class**
High	67%	50%
Average	33%	50%
Low	0%	0%
None	0%	0%

The amount of effort you put into this course has been	% Responses	
	Online based Class	**Traditional Class**
High	47%	61%
Average	53%	39%
Low	0%	0%
None	0%	0%

The intellectual challenge presented has been	% Responses	
	Online based Class	**Traditional Class**
High	40%	56%
Average	53%	44%
Low	7%	0%
None	0%	0%

Usefulness of online discussion group	% Responses	
	Online based Class	**Traditional Class**
Excellent	33%	22%
Very Good	33%	28%
Good	13%	28%
Fair	13%	22%
Poor	7%	0%

Your involvement in this course (doing assignments, etc.) has been:	% Responses	
	Online based Class	**Traditional Class**
High	53%	56%
Average	47%	39%
Low	0%	6%
None	0%	0%

Opportunity for practicing what was learned has been	% Responses	
	Online based Class	Traditional Class
Excellent	7%	39%
Very Good	40%	22%
Good	20%	28%
Fair	27%	6%
Poor	7%	6%

Table 4: Student Satisfaction by Class

Results from the teaching evaluation survey were also illuminating. These results are presented in Table 5. It is quite evident that the students in the Online-based class had a similar instructional experience than those in the other section. Analyzing the data presented in table (5), it is evident that vast majority of students were satisfied with the Online based course offering. There are a number of factors that may have contributed to this perception. From a student perspective, though, two factors come to mind. It is quite likely that the majority of students were self-motivated and self disciplined to find Online-based courses satisfactory. The second factor is the online students are better academically. The GPA for the online students was 3.25 compare to 2.60 for the traditional student.

Students were asked if they would recommend this course to others. As the data in Table 6 show, most students would be willing to recommend this course. There is however, a substantial degree of satisfaction among those students enrolled in the Online based class as well as the traditional class. The results show that 80% of the online students reported that they would recommend this Internet delivered course if offered to other students while 100% of the Traditional students would recommend it to other students.

The effectiveness of the delivery format has been	% Responses	
	Online based Class	Traditional Class
Excellent	27%	39%
Very Good	53%	44%
Good	13%	17%
Fair	7%	0%
Poor	0%	0%

Table 5: Teaching Evaluations

Clarity of instructor handouts	% Responses	
	Online based Class	**Traditional Class**
Excellent	20%	56%
Very Good	40%	39%
Good	27%	6%
Fair	13%	0%

Even though I do not meet the course instructor regularly in a classroom, I think that the instructor's overall contribution has been	% Responses	
	Online based Class	**Traditional Class**
Excellent	53%	50%
Very Good	33%	44%
Good	7%	6%
Neutral	7%	0%
Poor	0%	0%
No opinion or do not understand the question	0%	0%

Instructor as a discussion moderator/facilitator has been	% Responses	
	Online based Class	**Traditional Class**
Excellent	40%	50%
Very Good	47%	33%
Good	7%	17%
Fair	7%	0%
Poor	0%	0%

Quality/helpfulness of instructor feedback has been	% Responses	
	Online based Class	**Traditional Class**
Excellent	33%	33%
Very Good	20%	50%
Good	27%	17%
Fair	20%	0%
Poor	0%	0%

would you recommend this course to others?	% Responses	
	Online based Class	**Traditional Class**
Yes	80%	100%
No	20%	0%

Table 6: Student Recommendations to others

Finally, students were asked if someone were to ask you if they should take this course, what would you say? (All student replies are included verbatim)

a. **Responses of Traditional Class**

If someone were to ask you if they should take this course, what would you say	

1. yes
2. I would highly recommend this course because it covers a wide range of topics.
3. It is a very helpful course.
4. Yes, it will help you as an individual, especially verbal and written communication.
5. I would say yes. I have definitely learned a lot and I very much enjoyed the class. It was interesting and informative. And the professor wasn't half bad!
6. I would tell them to definitely take this course with this instructor. I have outlined several things here that I think could use some improvement. But, I would like to say that I thought this was a fantastic course overall. I felt extremely challenged, and also that the instructor sincerely cared about teaching this material. I also enjoyed the discussions and sense of humor of the instructor. Although I felt it was challenging to do well in this class (which is how I think college classes should be) I had a lot of fun and looked forward to coming to school.
7. I would yea, if you want a good grade with some effort
8. I would tell them it is an interesting course and you will learn a lot
9. only if you are willing to do a lot of work for a medium grade
10. Ive already been asked this questions numerous times... My advice is to be prepared to assume worthwhile tasks.... and take no one else besides Professor Orabi
11. I would and already have said "take this course, you will like it". I enjoyed this class and I liked Prof. Orabi.

b. **Responses of the Online-based Class (Online section):**

If someone were to ask you if they should take this course, what would you say?	

1. Yes, but it is a lot of work at least the on-line version. It takes up a lot more time than just sitting in a classroom. You need to be able to discipline yourself to do the work.
2. I would recommend them doing so, there is learning in all that we do.
3. Be prepared
4. Absolutely you will have a blast and leave with a better appreciation for the engineering field.
5. Yes, but there is a lot of work and material to be learned. If you keep yourself disciplined and do the work you will learn a lot about the different types of engineering and will develop a better appreciation for engineers.
6. I would tell them that if they are self-disciplined and want to have a lot of fun to go for it. I would also advise them to take into consideration the group work and the time it consumes.
7. I would say yes, as long as that person can commit enough time to keeping themselves on task
8. I'm not sure
9. Yes, It was fun, but think hard about whether or not you are the type of person that is capable of taking an online class.
10. Yeah if you have a lot of time. I do think this course took a lot of my time even though it was on-line.
11. If you are self disciplined, yes; otherwise, no.
12. Yes, it is a good class to get an overview of the engineering field.

Student Problems

- Students encountered several technical problems during the first test. A few students encountered minor problems after the first test. Some initial problems encountered were due probably to the student's Internet service provider (ISP).
- Another problem sometimes encountered was that of "no grade". Some students could not see their results after submitting their test for grading. The instructor resolved this minor problem.
- An unconfirmed report suggested the possibility of some students taking the tests as a group. The student performance doesn't support this claim. A way to eliminate this

cheating possibility is to have students take the tests in a controlled environment such as in a school lab or public library together. However, this will eliminate some flexibility, defeating the purpose of Internet courses. Another measure that could be taken and was used during the online class was to reduce the time the tests were available online to 6 hours, still allowing room for some flexibility.

- A few of the students expected the instructor to be on duty twenty-four hours, seven days a week until the end of the course.

Recommendations for Online Instructors:

For the online delivered course, improvement is necessary from both the students' and instructor's perspective. It is clear that the course delivery, support, and the student's prior mastery of the Internet contributed to the satisfaction levels. Presumably future classes will benefit from some of the lessons learned here, and result in more satisfied students. Some of the things that require improvement are:

- Online-based courses should be clearly designated and advertised as such to prevent student confusion at the time of enrollment.
- Students should be informed regarding course delivery methodology and the requirements for student participation. This is particularly important from the point of view of student satisfaction, as students' expectations must be molded to fit the constraints of Online based course delivery.
- Course delivery platforms need to provide more stable and consistent delivery of their content. It would also help if these platforms were more flexible in allowing the instructor to tailor them to meet class requirements.
- Support for Online delivered classes needs to be expanded. Both students and instructors require support. Student and instructional needs may differ, but lack of support leads to low satisfaction in both groups.
- Clear and specific specifications for the student's computer hardware, software, and telecommunications must be published prior to course registration so that enrolling students can be ready to participate in the online course.
- A less-opened course structure should be given to help students avoid procrastination; and providing ways to encourage student-to-instructor communications
- A final area that may be out of the hands of students and instructors is rapid and consistent access to the Internet. Although high speed Internet access is slowly becoming available in urban areas, it will take some time before it becomes

widespread. This situation limits the features that instructors can use when delivering web content.

Conclusion

This study that compares the Traditional (face-to-face+ web) students with online students shows no significant difference in the learning of students as shown through regular test and other course requirements. However, it is clear there was some slight higher performance in the online student group. To eliminate the ambiguity from this study, the study will be repeated in the fall of 2003 where an online version and Traditional format will be again offered concurrently. In all, students favored the flexibility and convenience of the online course. They appreciated being well informed by the instructor of the expectations, objectives and concepts of the course, and the overall organized nature of the course. Nonetheless, students identified ways to improve the online course experience.

The key to successful online and traditional classrooms is to analyze course material, determine how well existing material will translate online, creating new approaches to communicating with students, and evaluating and rebuilding the course as problems arise.

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