AC 2012-3124: ONLINE DELIVERY OF A PROJECT-BASED INTRODUCTORY ENGINEERING COURSE

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Introduction

Engineering education is increasingly moving to nontraditional delivery modes, especially online delivery. According to Allen and Seaman, "Over 5.6 million students were taking at least one online course during the fall 2009 term; an increase of nearly one million students over the number reported the previous year."[1] This represents a 21 percent growth rate while there was only a 2 percent growth rate for higher education student population.[1] With this movement comes the challenge to meet the quality offered by traditional face-to-face instruction. In the online environment, it is often difficult to present complex engineering concepts. Also, the logistics of implementing team design projects into an online course is very complicated. An introductory engineering course typically addresses both complex engineering topics as well as team-based design projects. This paper reports on the development and delivery of an introductory engineering course for online delivery that includes team-based design projects.

Some previous work has been done with regards to moving engineering courses to the online environment. Enriquez developed an introductory circuits course for synchronous online delivery.[2] He found no statistical difference in the performance of the online students as compared to face-to-face students. Orabi showed no significant difference in the performance between online and traditional students in an entry-level engineering course, but the online students found it easier to fall behind in the content.[3] Kamp et al. evaluated e-learning in engineering education and concluded that online graphic visualizations were useful, distance-based student teamwork posed challenges, and instructors spent extra time in order to be successful in the virtual environment.[4] Brodie found that problem-based learning using online environments could be very successful and even enhance the flexibility in learning.[5]

The assessment methods used by others compared demographic data, class grades, and surveys. McBrien, Joens, and Cheng employed paper surveys and hand tabulated the results to assess the effectiveness of virtual classroom software.[6] Orabi's assessment tools included student performance, a survey assessing the student's satisfaction with course, and a discussion of the instructor's experience.[3] Enriquez employed comparisons of student performance, usage of online resources, student demographics, and a student survey to assess the attitudes of the students.[2] The study considered by this paper employed all of the assessment techniques discussed above.

This paper begins with background information as to why the course was developed for the online environment for the UW Colleges and the challenges that accompany the online delivery mode. The process used to develop the course, the course content and delivery methods used will be discussed. The results from the assessment of the course are then given. Finally, some conclusions and future work are discussed.

Background

The University of Wisconsin Colleges (UWC) is part of the University of Wisconsin System. The UW Colleges are composed of 13 two-year campuses geographically dispersed across the state of Wisconsin. The UWC mission is to prepare students for success at the baccalaureate level of education. The University of Wisconsin Colleges has been offering the first two years of general engineering courses for over 30 years. The curriculum is offered via face-to-face instruction at five campuses and via distance education (DE) to the other campuses. Prior to 2007, the DE courses were offered synchronously using either audiographics or compressed video. Audiographics utilizes Microsoft Live Meeting, the participants are connected via a telephone conferencing system and share a computer screen. The faculty member controls the computer and the meeting in real time. Compressed video is a teleconferencing system where the faculty member can connect via video to five remote campuses. Both methods require students to attend class at a specified time and day. The students must be physically present at their campus to attend the course. The student could possibly attend the class meeting from a different location, but the cost is prohibitive for this method of delivery, therefore the students are required to be at one of the UWC campuses.

The UW Colleges are collaborating with the University of Wisconsin – Platteville (UWP) for a Statewide Collaborative Engineering Program. In this program, the UW Colleges would offer the general education requirements including math, physics, chemistry, and lower-level engineering courses and UWP would offer the upper-level engineering major courses. The UWP courses would be offered online via streaming video with idea being that place-bound students could attain an engineering degree without moving to Platteville. The target audience for this program is working individuals who will not be able to attend courses offered during the typical working day. This is not the audience currently being served by the UW Colleges DE course delivery which is scheduled during normal business hours. In response to this, the UWC faculty determined that the current course offerings would need to be developed for an asynchronous online delivery mode. The UW Colleges has a robust instructional design staff that will help faculty design their courses for online delivery. Over the last four years the engineering faculty have migrated all of the courses to the online environment. This paper discusses the online development and delivery of the Engineering Fundamentals course for online delivery.

Course Background

In 2006, the UWC faculty decided that students were not being well served by a one-credit Introduction to Engineering course. The faculty felt the students were not leaving the course with the skill set required of an engineering student, specifically the ability to work well in teams, the ability to efficiently and effectively solve engineering problems, an overall understanding of how a practicing engineer will use technology in their work, as well as a fundamental understanding and use of a spreadsheet program. This was further evidenced by the fact that the faculty felt that students were not performing to their expectations in subsequent courses. A new course titled Engineering Fundamentals (EGR 105) was developed and offered initially in the fall of 2007 in both a traditional face-to-face format as well as compressed video delivery. It is a 3-credit course where 1/3 of the course would be devoted to an introduction to computer science and computer applications, specifically spreadsheets. The course description is as follows:

This course is designed to equip engineering students with the necessary tools and background information to prepare them to be successful engineering students as well as a successful practicing engineer. Topics covered in this course include project management, team work, technical writing, working with data and using spreadsheets, creating presentations, engineering design, and a thorough understanding of the engineering profession.

The course learning objectives for EGR 105 are as follows, the student will:

- develop project management and team work skills and apply those skills to engineering design projects
- learn how to solve quantitative engineering problems by creating and utilizing spreadsheets
- develop oral, written, and graphical communication skills that will be used throughout the students engineering education
- develop elemental quantitative skills that will be used in introductory engineering coursework
- develop an understanding of the engineering education expectations for various careers and participate in engineering career exploration

Challenges

Moving a course to the online/asynchronous environment is challenging for the faculty member regardless of the course. The time requirement for developing a well-thought-out and media-rich online course is much higher than a traditional face-to-face lecture. The development team determined several challenges that exist from delivering EGR 105 in the online/asynchronous environment. The challenges are due to the geographical dispersion of the students and their inability to physically meet with the professor during the semester. As with many engineering courses, especially project-based introductory courses, teamwork is vital to the success of the students. With students located all over the state, and potentially all over the world, teamwork becomes very challenging.

Another integral part of the traditional introductory engineering course is the inclusion of the perspective of outside practicing engineers. This usually takes the form of either a field trip to the practicing engineer's company or bringing the engineer to class as a visiting lecturer. For reasons stated above, this becomes a challenge in the online environment.

Oral communication is an important aspect of any engineer's career. For this reason, it is emphasized in the traditional introductory engineering course. Given that students are geographically dispersed and courses are generally delivered asynchronously in the online environment, including an oral presentation into the online delivery of the course is a major challenge.

There are several other difficulties that occur with any course (not just engineering courses) being moved to an online environment. Some of these challenges include the students adequately grasping new concepts, the inability to ask questions in real-time, the assessment of student understanding which comes from being able to see their body language, the logistics of the technology working as intended, and many other issues. The preceding are some of the challenges unique to this course. These challenges were all addressed and met to the satisfaction of the faculty. Details of how the challenges were met are in the course content section of this paper.

Course Development for Online Delivery

The development of the course for online delivery took over eight months and can be broken into three stages: identifying the course components, designing the delivery method for each component, and developing the course content. These three stages are discussed below.

Stage 1: Course Component Identification

In order to prepare for online delivery, the UWC engineering faculty and instructional staff met to discuss the course components of EGR 105. The timing was deemed appropriate as the course had now been offered for three years and a curriculum revision may be warranted. Each attending member listed the specific course topics they covered in the course. The topic lists were compiled resulting in over 60 potential topics for the course. The 60 topics were then categorized into one of three areas: computers/applications, engineering principles, and team/project design. Within each category the attending faculty ranked the topics in order of importance and the highest ranked topics were identified as the course components that should be covered regardless of the mode of delivery. Approximately 1/3 of the course content was given to each category. The members discussed the various lessons and methodologies used in class to cover the components and developed a topical outline for every day of the course.

Stage 2: Lecture Design and Delivery Strategies

A smaller group of faculty members met a few weeks later to plan the course for online delivery. The course design team was comprised of three engineers and a computer scientist. Each member in the team had different educational and working backgrounds. The lead designer was the faculty member that would first deliver the course in the online environment. All team members were given access to the online course so that they could access the developed course lecture notes, homework, projects, and other developed material.

First, the team created a course schedule by identifying the order of the topics. The course would be comprised of 45 lectures representing a 15-week class that meets three times a week. Each topic was placed into the schedule, and the corresponding delivery strategy was determined. A team member was designated to be the developer of the content for each lecture. This team approach to development allowed each member to work in the area where they had expertise. The team tried to split the work evenly, but the lead instructor created approximately 40% of the lectures. The computer scientist created about 30% and the remaining lectures were split among the team members.

The course design team then discussed the textbook to be used for the course. Each attending faculty member used a different book, therefore the pros and cons of each text were discussed. At the conclusion, the team determined it would be best to create a custom book by pulling chapters from several different texts. This confined the selections to a single publisher so a custom book could be easily created. The team decided to use Mc-Graw Hill from which chapters were selected from different books for each topic covered in the course.

Stage 3: Developing Course Content

The lead instructor supplied each team member with a lesson template so that the format of each lesson was the same to provide continuity in the course. Each team member then began developing their lectures. Each member worked with the lead instructor and the online instructional designer to create the lecture material for each topic in the course. The lead instructor also worked with Mc-Graw Hill and created a custom textbook for the course based upon the chapters selected. The team used some innovative approaches to lectures and project team work. The approaches and methods used to deliver the course content are in the Course Content section of this paper.

Course Content

The team felt it would be easier for the students to work in units that aligned with a calendar; therefore, the EGR 105 course is comprised of 15 units which coincide with a 15-week semester schedule. As discussed previously there were three categories identified for the course: computers/applications; engineering principles; team/project design. The team determined that each unit would be comprised of 3 lessons equating to the three categories of the course. Two lessons in each unit were devoted to engineering principles and team/project design and one lesson was devoted to computer science/applications. Each lesson was comprised of lecture notes and videos, reading assignment, and homework. The lecture notes were developed by a team member, the reading assignment was from the custom Mc-Graw Hill textbook, and the homework was either from the textbook or created by team members. The assignments were completed on an individual basis. The students' grades were determined by these 14 weekly assignments as well as two team-based design projects and a final exam.

The team felt that this information covered a majority of the material that would be delivered in a face-to-face class. The team did feel that the student taking this course in the online environment would be missing certain course components that face-to-face students would receive, specifically those topics addressed in the challenges portion of the paper. The following sections illustrate how the team addressed each of the challenges presented earlier.

Team/Project Design Work

The team determined that the students in the EGR 105 course would be required to complete two team project design projects regardless of the mode of delivery. The course design team discussed the various projects each have employed in previous courses and two projects were selected for development. The projects are somewhat scaled back as compared to projects typically done at a baccalaureate campus due to the lack of equipment and the geographical dispersion of our students.

The first project is the Mouse Trap Car project. This is a typical high school physics project, but members of the team have used this project before with great success in this course. The project is to for teams to design a single car powered by a mousetrap, create specifications, engineering sketches and assembly directions. From the team-created technical documents, each student built a car and tested it. The results were compared and analyzed to identify flaws in the specifications and/or assembly instructions. The documents were then revised to ensure a more repeatable design. A final car was built by a student team member and mailed along with the specifications to the instructor for final assessment and testing. All of the cars were tested by the instructor and the winner was declared. A portion of the final project score was based on how well each car did. The testing was recorded and posted on YouTube for the students to watch.

The second project was the Wind Farm project. The project was to design a wind farm to meet the electrical needs of a campus. Students were given hourly wind data for a year as well as electricity usage data for a campus. Students analyzed the data and researched specific windmills on the market in order to design a wind farm for campus. The deliverables for this project were a written progress report as well as a final written and oral proposal (detailed in a later section).

The faculty members determined that each student team would be composed of 3-4 students selected and assigned to a team randomly. The next hurdle was to determine how the students would communicate efficiently with each other so that they could complete their projects. Multiple methods of communication were used including email, virtual classrooms, and discussion boards. The students could also use their own social networking systems as well as their mobile phones. In addition, there were online discussion boards that were used by the entire class, and there were boards that were used for the team to hold private conversations. The threaded discussions were maintained throughout the semester.

Another method of communication was the use of a virtual classroom. The UW Colleges uses the synchronous meeting tool Blackboard Collaborate. This meeting room allows for VOIP communication, the use of Whiteboards, application sharing and web tours as well as break out rooms for private discussion. In order to guide students in using this tool, the lead instructor held a mandatory virtual meeting during the first week of the semester. The main purpose of the meeting was to introduce the students to Blackboard Collaborate and explain how to use all of the conferencing tools. Each team was given their own individual team meeting room where they would be the only participants in that room and they could meet with their team members.

To help further the students' understanding of an engineering design project, the lead instructor acted as the project manager for the first project. The students had weekly milestones for their project that were addressed in their weekly assignment. For the second project, the students would elect a project manager and they submitted a single progress report half way through the second project.

Oral Presentations

The final component of the wind farm project was for each team to have a final presentation of their design proposal to the entire class. The faculty felt strongly that this presentation needed to be made to the entire class so a synchronous meeting was created as part of the course. The final project presentations were held in the virtual classroom the last day of class for two hours. This was a mandatory meeting and the students were informed of this meeting prior to the beginning of the course.

Engineering Professionals

As stated earlier, one of the components of a face-to-face EGR 105 course is the interaction with a practicing engineer. Either the engineer would visit the class or the students may visit the engineer at his/her job. In response to this the faculty determined that practicing engineers would be interviewed and videos of the interviews were made available to the students. The lead instructor developed a set of questions that corresponded to the lessons in each of the 15 units developed. Two engineers were identified (a civil and a mechanical engineer) each with over 20 years of working experience to be our interviewees. A camera crew was sent from the instructional designer and interviews were conducted. The interviews were held at different locales, but were edited into one single recording for each unit. The interviews were more robust than anything that could be delivered in a face-to-face course as the practicing engineers discussed how he applied the topic of the unit in his daily activities.

Connecting with Students

The challenge with any online class is the ability of the professor to connect with his/her students to ensure the understanding of key concepts. The students do not have the ability to drop by the faculty member's office and obtain help. The lead instructor employed the use of virtual office hours utilizing the software program "Blackboard Collaborate". The lead instructor had over 4 semesters of experience with the virtual classroom and has found great success in connecting with students.

The use of the virtual classroom, online office hours and the practicing engineer interviews were all used to help meet the challenges of offering the EGR 105 course in an online environment. The faculty felt that these methodologies would help the students receive an educational experience similar to the experience they would receive in a face-to-face delivery mode.

Assessment

During the same semester the online course was initially offered, it was also offered in its traditional format by a member of the course design team. Assessments were conducted to compare the online course to the traditional face-to-face delivery mode. The traditional face-to-face delivery served as the control section, whereas the experimental section was the online delivery. Comparison to the compressed video delivery method is beyond the scope of this paper.

The course content was nearly identical between the two modes. All the homework and projects were the same in each section. Also, each section followed the same weekly schedule so the concepts would follow the same order. Of course, small changes were made in order for the content developed for online instruction to effectively fit into a face-to-face delivery format of 75 minutes, twice a week.

The goal of the team was to ensure that the students in the online section had similar experiences and successes as the students in the traditional face-to-face section. Several assessments were used to determine this. One assessment was a quantitative analysis comparing the grades of each section. Also, two surveys were created for the students to take and reflect on their work on the projects and the course. The first survey was given after the first design project and focused on teamwork on the project. The second survey was conducted at the end of the course focused on both the final project as well as the course as a whole. Another assessment was an analysis of how students utilized the engineer interview videos for each section. Finally, the instructors for each section discussed their perceptions of the course, the projects, the students and the overall experience of the course at the conclusion of the course.

Due to the registration complexities of online students, the only demographic data available for analysis was age and gender. The face-to-face section consisted of 15 students (14 males and 1 female) while the online section had 26 students (22 males and 4 females). The age distributions for the two sections are shown in Table 1. Note the face-to-face section was younger overall having an average age 24 years as compared to an average age of 28 years in the online section.

Section	Under 18	18-20	21-25	26-35	35-45	Over 45	Average
Online	1	4	8	8	3	2	28
Face-to-face	0	7	4	3	1	0	24

Table 1: Age distributions of online and face-to-face sections

Student Grades

The first assessment tool used to compare the two sections was student grades. Since identical assignments were given in each course section, a direct comparison of grades between the online and the face-to face section was made. While there was some subjectivity to grading, a rubric was created for each assignment and project which helped normalize the grades.

Table 2 shows the results of the grade comparisons for each section. The mean score for each assignment, project, and final exam are given. Table 2 also shows the resulting p-value from the two-tailed, heteroscedastic Student's t-test for each assignment. For this analysis, if the p-value is less than 0.01, there is a statistical significance between the sections. A noticeable result from this comparison was how much better the online students did as compared to the traditional students. The p-values for three assignments, the mousetrap car project, the take home Excel final, and the overall course grade were less than 0.01 indicating a statistically significant difference in these grades. In each case, the online section did significantly better than the traditional section.

These results are consistent with the results of a 2010 Sloan Consortium study surveying the perceptions of the quality of online instruction. In the survey, over 75% of academic leaders at public institutions report that online is as good as or better than face-to face instruction.[1] A speculation for this difference may be due in part to the quality of the students in each section as opposed to the delivery. Both instructors had previously taught the course several times, the online instructor reported that the students in the course were some of the most well prepared students she had ever had, while the face to face instructor reported that the students in the course were some of the most ill prepared student he had ever had. Nonetheless, with the better section being the online students, there is little concern that the content was not delivered adequately via online delivery.

From Table 2 it can also be seen that the assignment from Unit 11 was relatively low as compared to the other assignments. The assignment was on unit conversions and consisted of an exceedingly large amount of conversions to be done by hand as well as using Excel. It was not that students were unable to execute unit conversions; it was that students were unable to complete all the conversions. The assignment was too long and will be shortened in the future. Overall, when comparing the grades of the two sections, the online students performed better than the traditional students demonstrating that the online delivery was more than adequate in achieving student comprehension of the topics.

Assignment	Online Mean	Traditional Mean	P-value
Unit 1 - Introduction	95.7%	100.0%	0.13349
Unit 2 – Teamwork/Basic Excel	**93.8%**	**80.5%**	**0.00933**
Unit 3 – Writing/Design Cycle	88.4%	76.6%	0.13740
Unit 4 – Drawing/Intermediate Excel	89.5%	78.4%	0.04184
Unit 5 – Transferring/If Statements	**89.6%**	**58.7%**	**0.00578**
Unit 6 – Resumes/Graphing	93.4%	75.7%	0.01944
Unit 7 – Ethics/Algorithms	81.4%	59.6%	0.10376
Unit 8 – Project Management	84.6%	64.9%	0.12049
Unit 9 – Statistical Analysis	92.8%	76.2%	0.02808
Unit 10 – Numbers/Pivot Tables	82.1%	68.5%	0.08296
Unit 11 – Units	**72.5%**	**34.7%**	**0.00342**
Unit 12 – Project/Functions	86.4%	66.2%	0.09971
Unit 13 – Oral Presentations/PowerPoint	86.5%	72.4%	0.16086
Unit 14 – Issues in Engineering/Program Structures	90.4%	57.3%	0.02722
Project 1	**95.7%**	**88.9%**	**0.00067**
Project 2 Presentation	90.6%	66.5%	0.01913
Project 2 Proposal	90.7%	67.8%	0.02644
Take Home Final	**87.8%**	**50.8%**	**0.00718**
In Class Final	84.3%	66.8%	0.03748
Total Grade	**90.9%**	**70.2%**	**0.00076**

Table 2: Grade comparison between traditional and online sections

Student Survey of the Mousetrap Car Design Project

The first student survey was given after the mousetrap car project. The survey asked ten questions on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree) regarding the first project and how well the teams were able to work together as well as their overall impression of the project. This survey was given to both the traditional face-to-face section as well as the online section and a Student's t-test was performed to compare the results between sections. Table 3 shows the results for each question on this survey including the averages and p-values from the t-test. The average score is above four for all questions in both sections. The students seemed to have a positive experience with the project including working with their teams. Table 3 shows the p-value for each question is above 0.01. Therefore, there is no statistical difference in the responses of the two sections. The fact that both sections had an equally positive response to the project demonstrates the methods used in the online delivery lead to an experience equivalent to what is traditionally offered.

Question	Online Mean	Traditional Mean	P-value
1 - My design team worked well together	4.56	4.38	0.5053
2 - The communication in my design team was good	4.56	4.08	0.1226
3 - My design team was able to regularly find a time for everyone to meet	4.67	4.15	0.1032
4 - The meeting place used by my design team was effective	4.56	4.31	0.4109
5 - The mousetrap car project effectively demonstrated how to work with a design team	4.56	4.62	0.7935
6 - The mousetrap car project effectively demonstrated how to manage a design project.	4.22	4.31	0.8087
7 - The mousetrap car project effectively demonstrated the engineering design cycle.	4.56	4.31	0.2773
8 - The mousetrap car project effectively demonstrated creating design specifications and assembly instructions.	4.67	4.31	0.1109
9 - The mousetrap car design project was an appropriate amount of work.	4.11	4.23	0.6514
10 - My overall impression of the mousetrap car design project was positive.	4.67	4.54	0.6104

Table 3: Results from student survey following Project 1(Mouse Trap Car Survey)

The qualitative data revealed similar comments in that both sections had an overall positive experience with the project. However, the qualitative data revealed dissimilar comments when discussing teamwork. The traditional section had comments that suggested it was difficult to find time to meet as a team, that more “in-class time” should be given for the teams to work together and that the students would prefer to pick their own teams. The online section overwhelmingly had positive comments regarding the teamwork. The common theme in the comments were that it was easy to meet as a team, the use of Blackboard Collaborate was indispensible in allowing them to work as a team, and that they felt they really got to know their teammates. From the student information gathered in the first assignment it was known that most of the online students had full-time jobs and had scheduled time in the evening to work on their coursework. Therefore, it seems that the online students had an expectation of doing work at night. In contrast, the most of the traditional section students worked outside of normal school hours (evenings and weekends) and therefore, it became difficult to meet as a team outside of traditional school time.

Student Survey of EGR 105

The second student survey was given to each section at the end of the course and considered student’s reactions to both the wind power project and the course as a whole. There were 11 questions on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). Table 4 shows the results for each question on this survey including the averages and p-values from a t-test.

The first three questions considered the wind project as compared to the mousetrap car project. These scores were relatively low. The instructors were not clear as to why the scores were low, because overall the student comments were mostly positive. The traditional section students all stated they worked better as a team on the second project. Overall, they stated they found it easier to work as a team and get their work done. The online section had two of seven teams state they did not work well on the second project. One student commented, “I think our team worked better together on the mouse trap project because what needed to be done for the project was more clear cut.” Another noted, “The team did not function well at all. The initial meeting was only attended by 3 of 4 members and the scope of the project was beyond what anyone could comprehend.” The other five teams in the online section all reported similarly to the traditional section, in that the teams worked much better in the second project as compared to the first.

Question	Online Mean	Traditional Mean	P-value
1 - The wind farm project was more successful than the mousetrap car design project as it relates to the ability of our team to work together and accomplish the project.	3.22	3.92	0.2017
2 - Did you feel your team successfully "managed" the wind farm project? (i.e. did you apply and use project management principles?)	3.78	4.25	0.3878
3 - Team communication improved between the mousetrap car project and the wind farm project.	3.78	4.25	0.3627
4 - The Excel tools presented in the course were useful in completing the wind farm project.	4.33	4.5	0.5927
5 - The delivery of the course content was effective.	4.33	3.67	0.0758
6 - The textbook was useful.	**4**	**2.67**	**0.0089**
7 - The instructor(s) communicated effectively.	4.56	4.33	0.5147
8 - The pace and flow of the course was appropriate.	3.89	3.67	0.5027
9 - The course prepared me for future engineering classes.	4.44	4.08	0.2927
10 - The course had an appropriate amount of work for the level and number of credits.	3.56	4.08	0.335
11 - My overall impression of the Engineering Fundamentals course was positive.	4.44	4.17	0.4537

Table 4: Results from student survey following the course (Student Survey of EGR 105)

Questions 8 and 10 having to do with pace and workload also had relatively low scores. When the surveys were examined for comments, most students felt the work was appropriate and did not have a strong opinion regarding the amount of work. No one complained that the work was excessive, yet the scores do not reflect this. However, the instructors felt that the amount of grading was excessive for the course. Each week the instructors were required to grade three assignments; an engineering assignment (typically two sections), a computer assignment, and a project assignment (for the first half of the course).

Finally, question 6 dealing with the textbook was not only low, but the traditional section was significantly lower than the online section with a p-value of 0.0089. There were some problems with the textbook including one section being out of order and that the chapter numbers in were not sequential making it confusing to determine where to look. These issues have been rectified for future offerings. The difference between the two sections stems from a lack of buy-in from the traditional instructor who historically used no text in the course. Aside from this question the p-values are all greater than 0.01 indicating there is no statistical difference in the responses of the two sections.

Engineering Interviews

As discussed earlier, engineer interview videos were created for each unit to show students how the week's material was applied in the "real world". The traditional section students were told to log onto a website outside of class to access the engineering videos prior to coming to the class each week. The online students had access to the videos along with their assigned readings and other course materials. The time spent by each class on the engineering interviews were analyzed. If was found that the students in the traditional face-to-face section only watched 11.7% of the videos as compared to the online section watching 68.7% of the videos. It seems the videos did not work for the traditional section and yet were better received by the online section.

The instructors felt the videos were a vital component of the course was concerned about the lack of student participation. The traditional section students may have viewed these videos an "optional or supplementary" activity that should be done in addition to attending the class. The videos for the online section were embedded into the course material. Therefore, when the students were reviewing the material for the unit the interview was one more component of the course and was most likely not viewed as an "optional or supplemental" component, but part of the course material. Future online course offerings will include graded assignments related to the engineer interviews in order to ensure students utilize them.

Instructor Perceptions of the Course

The final assessment was the instructors' perception of the course. The online instructor and the traditional section instructor had very different experiences with the course. During a meeting after the end of the semester, the traditional instructor noted that the cohort of students in the class were the worst group of students he has had in the three years teaching the course. The online instructor found that this was the most motivated and engaged cohort of students that she has had in her three years of teaching the course. This is possibly the result of the type of students who took the different sections. Based on information gained from the first assignment it was known that most of the students in the online section were non-traditional students working on attaining an engineering degree while working full-time and maintaining many other obligations, whereas many of the traditional face-to-face students were taking this course to "test the waters" and had little intention in attaining an engineering degree.

Both instructors tried to offer the course material in a similar manner, the traditional course was very structured and did not allow for "extra time" to be spent on a subject if the students struggled. If the students did not understand a concept they were required to come to office hours or spend extra time after class with the instructor. The traditional instructor found it nearly impossible to cover all of the course material in the allotted class time. The online instructor did not have similar experiences because the students were responsible for the material. The lecture notes, videos, and other information were presented in a concise and easy to follow format, but it was the student's responsibility to complete all of the course work. Therefore, the online instructor never felt pressure to meet a schedule for the delivery of the course material.

Both instructors reviewed the amount of time spent on this course as compared to previous semesters. Both instructors felt that this course was more time consuming than previous offerings of the course. As stated earlier, the traditional section instructor noted that he spent more time one on one with students outside of class. Overall, the traditional section instructor estimated that he spent 10 hours on the course each week. The online section instructor noted that she spent more time on the online course as compared to previous semesters. Much time is spent communicating with students in and out of virtual office hours, attending students meetings if requested and grading homework. The online instructor had 3 virtual office hours a week which were almost always attended by students, had over 1700 posts to the discussion boards throughout the semester, and as many emails in which to read and respond. On average the online section instructor felt she spent in excess of 20 hours per week on this single course.

The online instructor believed that the use of Blackboard Collaborate for the virtual office hours and synchronous meetings was vital to the success of the students in the online section and to their working as a team and producing quality projects. The use of Blackboard Collaborate aligns with Moore's theory of transactional distance. The theory states that distance is a pedagogical phenomenon and the learner is not considered with location, but with student interaction and engagement.[6] The use of Blackboard Collaborate allowed the students to be connected with the professor and with their teammates.

Both projects were reviewed by both instructors at the meeting after the end of the term. The instructors felt that the quality and level of detail presented by the online student teams far exceeded the projects of the traditional section teams. The quality of the presentations was superior for the online students, and the data analysis for the wind project was at a greater level of detail for the online students. Both instructors feel this may be attributed to the ability of the online students to work more effectively in teams than the face-to-face students.

Next Steps and Conclusion

The course will be offered again after some minor revisions. These revisions include making the course ADA compliant and changing the homework. The homework will be shorter and will include questions regarding the interviews for each unit. It is the belief that this will encourage students to view the videos. In the future, a comparison of the online delivery method and the compressed video method of delivery will be conducted.

The creation of a project based introduction to engineering course for delivery in an online environment was conducted and deemed a success. The online course was successful in that the online section students had better grades as evidenced by the data analysis and had similar experiences as the traditional section students as evidenced by the results of the two surveys. The engineer interviews were utilized more by the online students versus the face-to-face students. This may have been due to a perception that the videos were optional for the face-to-face students. Finally, both instructors felt the course was successful, but the level of work by the students and instructors was more than typical for a three credit course. The results show that project based introductory engineering courses may be successfully taught in the online environment.

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