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EMPLOYING THE CLASSROOM FLIP TO MOVE "LECTURE" OUT OF THE CLASSROOM

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A common challenge that professors face is to balance the need to lecture on important content with the desire to increase student engagement through the use of more active learning methods. This paper describes the use of the "classroom flip" technique to develop and implement a five-week module in a 100-student, architectural engineering course. The instructors "flipped" traditional content delivery out of the classroom by posting video lectures, and brought project based learning into the classroom where they could provide face-to-face assistance to the class. This paper describes how the classroom flip was implemented, including technology-related course changes that facilitated the implementation. Assessment of the classroom flip consisted of student surveys, comparisons of exam and project grades to a prior semester, and instructor insights. Student perceptions generally supported the use of the method for the purposes of providing instructor interaction while performing project activities and included valuable feedback about how the classroom flip should be used in the course. The statistical comparison of grade data between this course offering and the previous offering by the same instructors showed no significant change for either exam or project outcomes. The instructors considered the classroom flip to be a success based upon the increased student engagement.

Keywords: -

Introduction

Instructors in many educational domains, including engineering, walk a fine line in their classrooms. Many instructors are becoming increasingly aware of the need for students to be actively engaged in the material and desire to include active learning techniques in their classrooms. However, instructors also feel pressure, from departments, accrediting bodies, and their personal beliefs, to make sure that students are exposed to enough material to constitute "sufficient coverage." The classroom flip is an instructional method that can be used to include active learning elements in a class while maintaining the ability to cover critical course material (Baker, 2000; Dollar and Steif, 2009; Gannod, et al., 2008; Kellogg, 2009; Toto and Nguyen, 2009). In the classroom flip, also called the inverted classroom (Lage and Platt, 2000; Lage et al., 2000), the instructor asks students to use out-of-class time to watch a "virtual lecture" available online. By requiring students to watch the lectures as homework, the instructor frees up class time to lead students in other activities. In the classroom flip method, the role of the instructor shifts. No longer is the instructor the "sage on the stage" (King, 1993) in which the primary role is to transmit information during class time. Rather he or she uses class time to guide students through a variety of active learning exercises and allows for more student collaboration, without feeling pressure to "cover" necessary material. Particularly in the engineering domain, students need sufficient time to be able to practice problem-solving. Flipping the class provides additional time for the students to work out problems, while having the instructor there as a guide.

In this study, a classroom flip was implemented to move lectures focused on problem solving methods out of the classroom and to allow the instructors to offer different, active learning, exercises during class. The instructors also gained additional time to interact with students while performing their course project. This paper describes the implementation of the classroom flip in an architectural engineering (AE) course including the technology that was used. It also describes the challenges of implementing the method and its impact. Student and instructor perceptions of the method as well as data on the impact on student learning are also discussed.

Background

The classroom flip method was piloted in the spring of 2008 in a large undergraduate AE course entitled "Introduction to the Building Industry," which typically enrolls 100 students. The primary objective of the course is for students to learn and apply principles for planning and managing construction projects. The course incorporates concepts from business, project organization, and contracting methods with the use of problem solving for topics such as cost estimation and critical path method scheduling. The course consists of two 50-minute lecture periods and one 110-minute practicum each week during a 15 week semester.

The evolution of the course began, as many courses do, with the handoff of course and lecture materials from one instructor to another. In most educational settings, lecture is still the most widely used teaching method by instructors (McKeachie and Svinicki, 2006). The new instructor began to use PowerPoint during his lectures which offered the opportunity to enrich the lecture presentations through incorporation of multi-media content and enhanced sequencing of construction principles. While the effectiveness of a lecture may vary substantially from classroom to classroom, many students in lecture-based classes tend to assume a more passive role with less engagement with the course material (Ahlfeldt, et al., 2005; Hake, 1998).

To combat this challenge, the instructors added in-class problems and a team project to engage the students. As defined by Bonwell and Eison (1991), active learning requires students to "do more than just listen" and to "engage in such higher-order thinking tasks as analysis, synthesis, and evaluation" (p. 1). Examples of such activities are quite broad and may include problem or project-based learning, collaborative learning, and case-based learning. Engineering educators have espoused many different varieties of active learning techniques, as exemplified by Fang, et al. (2009), Linsey, et al. (2009), and Turns, et al., (2010). While the in-class problems and project were valuable, the instructors identified the need to provide more opportunities for students to engage in active learning.

The next important step toward the classroom flip was a college-wide initiative to promote the use of Tablet PCs for use in teaching [Wise, Toto, Lim, 2006]. From 2006-2008, over 60 faculty in the College of Engineering at the authors' institution began to use Tablet PCs in the classroom. The use of the Tablet PC was a key step that helped position the instructors for a shift to the classroom flip method.

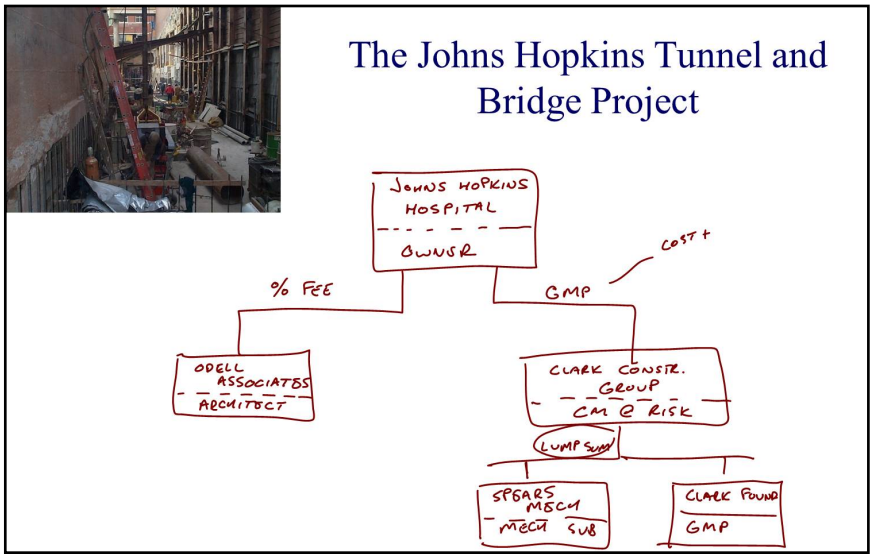

Figure 1: Annotated PowerPoint slide from class with a diagram of a project organizational structure for a case study project being discussed.

The instructors' initial uses of the Tablet PC, as illustrated in Figure 1, were fairly simple and in line with uses expected in engineering courses: sketching of diagrams, solving of problems, and annotation of images to

emphasize discussion points in the lecture. After the instructors began to use the Tablet PC consistently in the course, the presentations evolved to better allow the students to take structured notes . The instructors used PowerPoint presentations with certain material intentionally left blank so that students could complete them during class. Similarly, diagrams or equations were left blank and then completed by the instructor, allowing students to fill in blank areas in printed slides. While relatively simple in nature, these techniques are helpful in engaging the large groups of students in the lecture environment to improve the learning and preparation for the practicum activities (Nathan, 2010).

As a pilot effort, and with the use of the Tablet as an opportunity to highlight important content, the instructor began capturing class presentations. The authors' institution was one of the early adopters of the iTunesU initiative, which allows students to access videos specifically for courses. The initiative required relatively little cost and time investment. Necessary resources included software to capture the computer screen and a wireless microphone to capture the audio. In the spring of 2007, the instructor of the course started using iTunesU to post video-records of lecture material so that students would be able to review lectures and supplemental content.

The use of video-delivered lectures is not new in engineering education [e.g. Meyer, et al., 1997). With the advent of online, blended, and distance learning, many instructors use multi-media to deliver lectures virtually. Recent technology has made capturing presentations easier for faculty and more accessible by students. Software programs such as Camtasia Studio, Adobe Captivate, Camstudio, and UltraVNC Screen Recorder, to name a few, allow instructors to record spoken voice, video, and/or capture on-screen materials such as software demonstrations, worked problems, or PowerPoint slides. In addition, the use of course management systems makes the uploading of the class materials easy and secure. Preliminary feedback from students showed that they were open to the use of the recorded lectures (Zappe, et al., 2009). At first, the recorded lectures were intended as an additional resource for students which offered an opportunity for students who missed class to view the missed content or to review the live, word-for-word, presentations of the content. This gave students the ability to use it as a refresher of material for exams and to review topics which seemed unclear. Informal surveys at the end of the semester showed most students used the videos, with 92% stating that they used the videos throughout the semester.

The Classroom Flip

In the fall of 2007, with the first use of iTunesU having been fairly successful and well received, the idea for trying the classroom flip method in the course was discussed between the instructors and the staff of an education center in the College of Engineering at the authors' institution. Given the use of the Tablet PC for annotating notes and the lecture capture with iTunesU, discussions began on how the instructor could use these technologies to achieve a more active approach in the classroom. The instructors chose to try the classroom flip technology for several reasons. With the availability of online lectures as an existing resource, students would still be exposed to theory-based content, using outside class time. In addition, greater time would become available for in-class problem solving. Most importantly, there would be increased teacher-student interaction and more opportunities for active learning. Because the instructors of the AE course had already started to use technologies that made the classroom flip technique easy to implement, the classroom flip seemed an appropriate and manageable technique to try in the class.

Planning.

With a collection of classroom lectures already created as a resource for students, moving to the classroom flip occurred in two steps. The first step was focused on the preparation of the video content and preparing the students to be ready for using the video content. The video content captured from the previous year consisted of raw classroom presentations, which were shortened and edited to remove extraneous elements, such as dated announcements, tangential discussions, and miscellaneous down-time necessary in a live classroom setting such

as pauses to give students handouts. The finalized video was edited to deliver just the presentation content for a specific topic.

The second step was planning how to best use the time freed up in the lecture period to engage the students in active learning. In the classroom flip model, the purpose of the videos is not to replace time spent with the instructor. Rather, time with the instructor is used for the new purpose of engaging with the course material through active learning activities, which have been shown to be beneficial to learning (Hake, 1998; Prince, 2004). The major change in this study concerned the use of the practicum period, which had previously been used to deliver course content. The practicum period would now be used for students to work on group projects with the instructors available for assistance and guidance. Student feedback from previous semesters regarding the group assignments consistently indicated challenges associated with finding meeting times and the need for greater access to the instructors for feedback and assistance with fundamental tasks, like reading construction drawings, which were new to most students. Regular class time would be used for problem solving and other active learning exercises.

To achieve success when using the classroom flip method, it is important to ensure that students come to class prepared, having watched the online lectures; otherwise, the instructor may find it necessary to revert back to lecture to cover the material. The instructor must consider methods similar to strategies used for encouraging students to do outside reading, such as linking in-class work to the lectures, having assigned minute papers, or administering a brief quiz (McKeachie and Svinicki, 2006) either online or in-class. The use of online quizzes was the primary method used because it offers several benefits. First, the online quizzes increased the likelihood that students will come prepared for class by watching the virtual lectures. Second, the instructor can use the results of the quizzes as a launching point for discussion and adjust the class plan as necessary to address any student misconceptions or lack of understanding, in a form of just-in-time teaching (Novak, et al., 1999).

Piloting the Classroom Flip.

To test the use of the classroom flip, the instructors decided to focus on flipping one five week module of the course, rather than flipping the entire course. Prior to the implementation of the flip for the five week module, the instructors piloted the technique for a single lecture session during the second week of the semester. The purpose of the pilot was to test the process of editing and posting the video and to ensure students could access the video.

The video developed for the pilot effort combined content from two separate lectures presented during the previous year. Compiling multiple lectures, or selectively choosing content from several lectures, demonstrates the opportunity for instructors to select the exact content the students should review before class. The content in the pilot was composed of screen captures of the PowerPoint slides with recorded audio; there was no video of the instructor speaking. The PowerPoint slides used the Tablet PC, with a small amount of multimedia annotations on the slides. The video was edited to remove unrelated material, such as course announcements and discussions unrelated to the presentation topic. In addition to the posted video, a purely audio version was posted to allow students to listen to the presentation while traveling to and from classes. The PowerPoint slides from the presentation were also made available through the course management system to allow the students to take direct notes on the slides if they chose, replicating the opportunities presented in class for taking notes. A five-question online quiz was developed and posted in conjunction with the video lecture. The questions included content from the video and assigned text reading.

During the next class, the instructors introduced an active learning problem which they would be working through during the class period. After the brief introduction, the class stepped through an example of how to perform the activity. This presentation was followed by a period during class for the students to work either alone or in small groups on a similar scenario-based problem. At the completion of the exercise and class period, the instructor administered a “minute paper” (Stead, 2005) with three questions: 1) What questions do you still have about the topic or exercise?; 2) Did you like the flipped class (yes/no)?; and 3) What suggestion(s) do you have

for improving the activity? The responses regarding the perceptions of the method, which were mostly positive about the overall process, fell into three categories as shown in Figure 2.

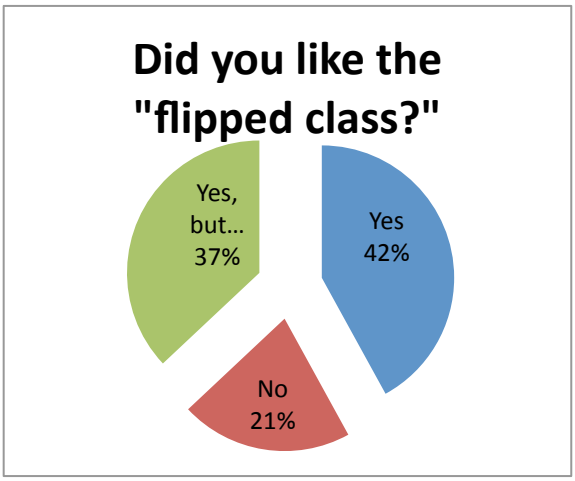

Figure 2: Pie chart of initial students' perspectives on the classroom flip

The responses clearly indicated that a majority of the class either enjoyed, or were open to, the use of this method. The written responses about improving the use of the method offered an opportunity to improve the delivery and fell into two main categories, suggestions for improving the process or delivery of the material, or comments which simply pointed out aspects that the students did not like. Out of the 95 students in the class, 25 responded that the video was too long. The piloted video was 50 minutes in duration. Based on this feedback, the other videos for the flipped class module topics were shortened to 25 to 30 minutes each. Further suggestions included:

- using more visuals rather than relying solely on PowerPoint slides,
- using the method sparingly during the semester and not as a regular teaching method,
- reviewing the video content briefly at the start of the class, and
- providing a means for students to ask questions, such as a message forum.

The other comments received about the method were more diverse. Some students expressed a preference for face-to-face delivery of lecture content. Several students noted that it can be harder to follow the video content as compared to class lecture, or that it is easier to become distracted from the videos. A few students stated that they felt the use of class for problem solving was simply an inefficient use of time, indicating it would take less time to perform the activity out of class than it took to review the lecture material. While this preliminary assessment focused on students' likes and dislikes of the method, further assessment on the longer modules focused on perceptions and evidence of learning. The student feedback was used to make improvements for the full implementation later that semester.

Implementing the Classroom Flip Module.

Later in the semester, the classroom flip was implemented for a five-week period focused on cost estimation. The cycle for preparation and use of the video content, as shown in Table 1, occurred on a three week rolling basis. The video content needed to be available early enough to allow students time to watch the video, do any necessary reading, and take the online quiz in advance of the topic. Videos were not posted in advance of every lecture period, but were used typically once per week to match main sub-topics for the cost estimation module. In addition, supplemental problems and solutions, which were not covered in class, were provided as additional video-recordings. Because the course already had a practicum period for performing problem solving activities,

the main change was to shift this problem solving content from the practicum to the lecture time. Moving this material from the practicum to the lecture was a relatively minor change because many problems and activities were already developed, and had already been administered through the practicum previously. Using these problems in the lecture period required only minor changes to account for the shorter duration of the lecture period, but allowed the instructors to interact with and assist many students in a 100 person lecture setting. Both instructors involved found this interaction much more enjoyable than traditional lecture delivery. One suggestion made by students during the pilot was to include a brief review period prior to each class session. As a result of the student feedback, the instructors reviewed the video content for 15 to 20 minutes during the first class session of the week with a shorter 5-10 minute review during the second session.

Table 1: Implementation schedule for the classroom flip, with preparation, two weeks in advance of the in-class topic.

Two weeks before topic	Video content from the previous year edited and posted for students
One week before topic	Students given access to watch video for coming week, along with any related text readings and the online quiz
In class	Instructors briefly review content and guide the active learning activity
Practicum	Instructors give brief suggestions about what to focus on during practicum related to the project, based on current class topics, then students actively work on their project with instructors available for questions and guidance

With the problem solving moved to what had previously been a lecture period, the practicum periods now provided time for students to work on their team project. The purpose of the team project is for the students to apply the concepts learned to develop a full estimate and a schedule for an actual building project. By having the students work on the estimating project during the practicum period, the instructors were readily available to provide guidance. Access to the instructors helped the students read and interpret the project drawings, answer questions about estimating for different building systems, and provide feedback to students in real time. It also afforded the student teams a consistent time and place to meet, with the added benefit of the instructors being available. In the previous offerings of the course, these activities were often limited due to the availability of the instructors outside of class based on the range of times students would be able to meet to work on their projects. In addition there was extensive organization required by both the instructors and students to document and submit questions or find times for teams and instructors to meet. Much, though not all, of this challenge was removed. Another benefit was that when a student or team raised a question that was valuable to share with the entire class, the instructors could share the answer with the entire class, saving much effort, and often much frustration, on the part of the students.

Assessing the Impact of the Classroom Flip

Assessment focused on three general areas. First, data was collected to examine students' reported use of the videos, including the number of times they watched each video and the amount of time spent watching the videos. Second, data was collected on students' perceptions of the classroom flip method, including specific questions about the use of the practicum time for active learning exercises. A final set of analyses was conducted to examine whether or not the classroom flip impacted student learning. Zappe, et al., (2009) provides a brief overview of students' reported use of the videos; therefore, only the most critical results related to use are described in this paper. Students enrolled in the "Introduction to the Building Industry" course at Penn State University during the spring, 2008 semester were invited to participate in the study. Of the 95 students enrolled in the course, approximately 80% were male with less than 10% minority representation. Most students in the class were juniors. In addition to the students enrolled during this semester, achievement data was obtained for

students enrolled in the same course during the spring semester of 2007 as a comparative data set. The demographic characteristics of students enrolled during the previous year match quite closely with 75% male and less than 10% from minority groups.

Table 2 displays information relating to the various instruments administered during the project including the time of administration, a basic description of the instrument, and the number of students who completed each. Student perceptions were measured using two surveys that were developed for purposes of the study. The content of the survey items stemmed from open-ended responses that students wrote regarding their perception of the classroom flip. The items were developed by the course instructors and individuals with expertise in educational psychology and educational measurement. Course Survey 1 (CS1) consisted of 21 items including a variety of open-ended, check-lists, and rating scale items. The questions asked the students how they utilized the online videos, what benefits they perceived from the flipped classes, and whether they preferred the flipped classes or traditional lecture. Course Survey 2 (CS2) was administered to the students at the end of the semester. The survey consisted of 35 items in which students were asked to rate their level of agreement to items measuring students perceptions relating to the classroom flip. Copies of CS1 and CS2 are available in Zappe, et. al (2009).

Table 2: Measurement Instruments for Assessment

Measure	Instrument	Time	Sample Size	Description
Course Perceptions	CS1	Mid-semester, Spring 2008	77	21 items (16 Likert scale, 5 other format)
	CS2	End-of-semester, Spring 2008	80	35 items (34 Likert-scale, 1 open-ended)
Achievement	Course Exams	Spring 2007	95	Subscores of multiple-choice items for topic areas on exam (cost estimating)
		Spring 2008	104	
	Team Projects	Spring 2007	23	Project submission score for team estimating deliverable
		Spring 2008	24	

Student achievement or learning in the course was measured by a course exam administered during the semester in which the classroom flip method was used and during the previous semester. Identical questions concerning the topics used for the classroom flip portion of the course were compared. A total of 18 multiple choice questions were used to measure students' understanding of cost estimating. Subscale scores were calculated for each student by summing up the correct number of items for each topic area. Free response problems were also used on the exams to evaluate students' ability to apply the course concepts. Exams consisted of approximately 60% multiple choice questions and 40% free response questions which were typically problem based. Scores on student team projects were also compared across the two semesters.

V. Assessment Results

Students' Perceptions.

The CS1 survey data indicated that students were watching the recorded lecture as assigned. Table 3 displays the number of lectures that each student reported watching. Approximately 70% of the students reported watching all four videos; an additional 18% reported watching three of the videos. When asked how often they typically viewed each video, a total of 83.5% reported watching them only once. A total of 48.1% stated that they almost always or often reviewed portions of the lectures that seemed unclear. Regarding their behavior with watching the videos, 37% stated that they watched each video straight through; an additional 28% stated that they watched the entire video and then reviewed unclear pieces. As one student stated, "I find it very valuable to have

the ability to go back and watch something to better understand it." A quarter of the students watched the video in one sitting but would pause and review certain sections. Most students (80%) reported spending between 30 and 45 minutes with each video. However, the majority of the students (73.4%) preferred that the videos would be 20 minutes or less; an additional 23% thought that 30 minutes was the ideal length for each video. Item means and frequency distributions are available for all of the individual items on the CS1 and CS2 surveys in Zappe, et al. (2009).

Table 3: Reported frequency of students who watched each video

Topic	N	% of survey respondents (79)
Project Delivery	73	92.4%
ROM Estimating	69	87.3%
Square Foot Estimating 1st	69	87.3%
Square Foot Estimating 2nd	59	74.7%

Students' perceptions of the actual iTunesU videos varied to some degree. A total of 18% of the students said that they had a difficult time following the video content. One reason for this may be that it is easier to get distracted while watching the videos, a statement endorsed by 45% of the students. Only 18% of the students said that the videos were enjoyable to watch. Yet, at the same time, a total of 54% of the students said the videos were effective for introducing new concepts; a total of 47.6% said they were useful for showing examples.

Some of the first videos proved to have inadequate resolution; a problem that was thought to be resolved by the time of the survey implementation. However,16.7% said the resolution was not appropriate for theoretical concepts and 42.5% said the resolution was not appropriate for showing examples. On the open-ended questions, one student noted, "[T]he resolution is so low on [the videos] that it is very difficult to read the numbers for calculations, which makes those videos practically useless to me." While the students noted that there were some difficulties, just less than 50% of the students said the videos should continue to be used to deliver theory-based content and to provide examples and solutions. In addition, almost 70% of the students said that the videos were a useful reference for the course; in comparison, 64% of the students thought that the textbook was a useful reference. One theme that emerged in the examination of the open-ended questions was that students found it helpful to review material on their own time, as illustrated by the student who stated, "I am able to focus better on lectures when I was most awake and assertive rather than at 10 a.m."

The importance of the quizzes as a "gate-check" for students' understanding emerged in the survey data. Only 32% of the students agreed that they would have watched the videos if they were not required to take a quiz; 30% disagreed and 66% were neutral. A total of 59% of the students agreed that the quizzes were beneficial for their understanding of the course content. Also, when asked if there were too many quizzes given, with one for each video, the students were almost unanimous that the quizzes were appropriate in number.

Overall, students had a positive opinion of the new use of the practicum and in-class time. A total of 79% of the students agreed that the use of the practicum for group projects was a good use of time. The vast majority of the students, 90%, agreed that having the course instructors available during project work was helpful to their understanding. A total of 61% of the students felt that the new use of the practicum for group projects was worth having to watch the online videos. When asked their perceptions about the amount of time dedicated to in-class activities, most students thought that the instructors were using the right amount, as indicated by Figure 3.

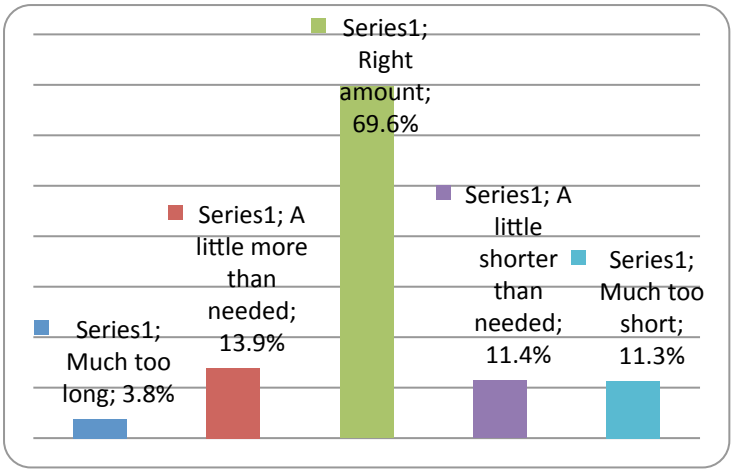

Figure 3: Students perception about the amount of time dedicated to in-class activities

The open-ended comments supported this positive view of the in-class time. For example, one student stated, "The in-class activities help because they're hands-on examples of what we're learning." Another student stated, "It is helpful to work through examples on our own, but still being able to ask questions if necessary." Yet another student stated, "I felt that the in-class activities were more interesting than listening to a lecture and helped me gain hands-on experience performing the task…" One final comment demonstrated the value of the relationship between the in-class activities and the videos: "Being able to work through various estimates and work through problems while having instructors around really helps to solidify what I've watched in the videos.

As mentioned above, brief reviews of the video content were added to each class session to refresh students' memory about the material and to provide an opportunity to ask questions. Almost 70% of the students agreed that the reviews were beneficial in transitioning to the in-class activity.

While many students reacted positively to the classroom flip, some students did not find the method to be as valuable. Some students did not like the new use of the class time, as typified by the following comment: "I found the online video just as informative as class. However using lecture time for practicum type exercises annoyed me a little. I felt like we were just doubling both lecture and practicum time." Another student stated, "Save the problem solving for practicum. This is the reason we have them. I get very annoyed when I have to do work in class and would much rather complete the work for a grade in practicum or as homework – and I would take it much more seriously which would help me on exams." Some students felt that the online videos prohibited them from asking the questions, as demonstrated by the student who said, "When I have questions about the examples the video doesn't always answer them." Several students still expressed the desire for alternative teaching approaches throughout the semester: "It is a good way to introduce the topic but it shouldn't be the sole way of teaching the material." An additional complaint of the students was the extra work required outside of class, as shown by the student who said, "The lecture should not be considered homework. Listening to lectures outside of class takes time away from other things, such as other projects. It just adds to the stress. It's easier seeing a lecturer in person versus just listening to a recording."

Potential effects of student learning styles on their responses to the videos were explored. The students were asked to complete the Index of Learning Styles and correlations were sought between style and responses. However no statistically significant correlations were found.

Impact on achievement.

As mentioned above, impacts on student achievement were measured using exam subscale scores across two semesters. Subscale scores for 104 students were available from the 2007 semester; scores from 95 students were available for 2008, when the classroom flip was implemented. Table 4 displays the descriptive statistics for the exam and project scores across the two semesters. An independent t-test was conducted to

determine the observed mean differences between the two semesters. The mean difference in exam scores was not found to be statistically significant (t = 0.245, df = 197, p = 0.807). Students were not found to perform differently on the estimating questions during the traditional versus classroom flip methods of instruction. While the project average scores did increase, the difference was also not found to be statistically significant (t=1.19, df=47, p=0.24). These results suggest that, at a minimum, no negative impact occurred in the student learning from the shift to the classroom flip method.

Table 4: Descriptive statistics for estimating exam question subscale scores

Year	Estimating Exam Subscale Scores		Estimating Project Team Project Scores		
	Average	Standard Deviation	Number of Project Teams	Average	Standard Deviation
2007	15.52	1.86	23	86.64	6.48
2008	15.45	1.98	24	88.44	3.65

Discussion

In general, the use of active learning strategies has been shown to promote better understanding of material in engineering and science disciplines (e.g. Prince, 2004). As Bonwell and Sutherland (1996) state, "Students are simply more likely to internalize, understand, and remember material learned through active engagement in the learning process" (p. 3). Similarly, Smith et. al (2005) state that "Students learn more when intensively involved in educational process and are encouraged to apply their knowledge in many situations" (p. 87) and "[t]o maximize students' achievement, especially when they are studying conceptually complex and content-dense materials, instructors should not allow them to remain passive while they are learning" (p. 97). While evidence for using active learning in the classroom is continuing to mount, some faculty members are still reluctant to try these new methods for several reasons (Michael, 2007; Michael and Modell, 2003). One reason is that some instructors are reluctant to change from traditional lecture-based formats as they feel compelled to "cover" course material. The classroom flip methodology allows the instructor to still cover content while using classroom time for other purposes.

Assessment of the impact of the classroom flip showed no effect, positive or negative, on grades on the class examinations and student projects. While differences in the project scores were not significant, careful examination of actual projects and information gathered on the process of project completion may help to elucidate the impact of the course changes. Also, the study is somewhat limited due the lack of a true control group. The data from the previous year was considered comparable but a true control group would provide a better picture on the impact of the classroom flip. Overall, students did positively perceive the new use of the in-class sessions, particularly with having the instructors available and being able to work on team projects during the practicum time. While the students did not seem to particularly enjoy watching the iTunesU videos as homework, many still understood the benefits they were gaining by the new activities implemented in the class sessions.

Other instructors who are interested in attempting the classroom flip may want to start with just one or a few class sessions. Students suggested that while the method provided value through the active learning enabled in the classroom, they would suggest limiting the use of the method with most students indicating a range of 25 – 50% of class periods being delivered in this manner. In addition, there was consistent feedback that each class needed to start with a brief review and highlighting of the key concepts from the videos. Instructors will need to balance providing enough review to refresh students' memory, while not completely covering the video content so as to reduce future watching behavior.

One key area that the instructors felt needed to be improved concerned ways to make the videos more interesting and visually stimulating. The video was purely the screen capture from the previous offering of the course and did not include multi-media content. As the current generation of students is very experienced with

multimedia content, the format used in this example is not likely to be extremely engaging for students. Simple things, such as including video of the instructor presenting, may improve the level of engagement for students. Including videos or animations may also help to increase students' engagement with the videos themselves.

Students' expectations regarding the appropriate length of the videos are another challenge. As mentioned previously, the instructors started by using videos that were as long as full-class sessions. Based on negative student feedback, the videos were shortened. Literature has stated that students' attention span during lecture is approximately 10-15 minutes (Hartley and Davies, 1978; Wankat, 2002), although individual differences have a strong influence on the ability to maintain attention (Wilson and Korn, 2007). Based on this research and on the students' feedback about the videos, the classroom flip is likely more effective if interesting and shorter videos are utilized.

Overall the instructors found the use of the classroom flip valuable, better accepted by the students than expected, and plan for its continued use. The major reason for this was the value identified by the students for the project guidance, and the enjoyment of the instructors in the increased interaction with the students. Preparing videos for the classroom flip was time intensive, but in addition to improved student engagement, the videos also offer consistency of the material delivery. The instructors intend to continue to refine course content and videos for the classroom flip portion of the course in hopes of achieving a better application of the method and measurable effects on student learning.

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