AC 2009-92: "FLIPPING" THE CLASSROOM TO EXPLORE ACTIVE LEARNING IN A LARGE UNDERGRADUATE COURSE

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"Flipping" the Classroom to Explore Active Learning in a Large Undergraduate Course

Key Words: active learning, teaching with technology, e-learning

Abstract

In traditional approaches to teaching engineering classes, the instructor plays the role of information conveyor, while the students assume a receiver role with primary responsibilities of listening and note-taking. Research into how students learn suggests that students need to be more actively engaged with the course material to maximize their understanding. The literature contains many examples of active learning strategies, such as teams solving problems in class and the use of student response systems with conceptual questions. Incorporating active learning strategies into a class means that there will be less time for delivering material via lecture. Therefore, instructors who choose to utilize active learning strategies must find ways to ensure that all required course content is still addressed.

This paper discusses an instructional technique called the "classroom flip" model which was assessed in a larger, undergraduate architectural engineering class. In this model, lecture content is removed from the classroom to allow time for active learning, and the content that was removed is delivered to students via on-line video. This approach 'flips' the traditional use of lecture and more active learning approaches. Lecture occurs outside of class, and more active learning, such as problem solving, happens during class. Assessment data was collected to examine students' use of the video lectures and perceptions of the classroom flip. The students' feedback suggests that while the active learning and additional project time available in class improved their understanding, they would prefer that only about half the classes be flipped and some use of traditional lectures should be maintained.

Introduction

Engineering instructors are often encouraged to try instructional techniques that encourage their students to be more actively engaged with course material. Active learning is defined by the engineering education community as the "involvement of students in their own learning."[1] Active learning encompasses a variety of instructional techniques, in which students participate in activities during class time that involve more than passive listening. Active learning techniques include in-class group work, think-pair-share, "clicker" questions using student response systems, and minute papers.

Active learning is necessary in order to increase understanding and for enhancing problem solving skills. The National Research Council has stated that "…the new science of learning is beginning to provide knowledge to improve significantly people's abilities to become active learners who seek to understand complex subject matter and are better prepared to transfer what they have learned to new problems and settings" (p. 13)[2] However, many instructors still utilize class time for lecture and are concerned that active learning consumes valuable time that is needed to cover material. The lecture method is often used as the primary method to make sure

that material is covered. However, the lecture method may not be the most effective way to ensure student understanding. As Felder (2003) states, "You have roughly 40 contact hours in a typical course. If all you do in them is lecture, you might as well just hand out your notes and let the students find something more productive to do with all that time." [3] Research has supported that active learning strategies result in higher student engagement and greater learning gains as compared to traditional instructor-centered methods such as lecture.[4] Even with the mounting evidence on the effectiveness of active learning strategies, instructors still struggle with this balance of engaging students and covering important material, especially in larger classrooms.

One method that allows instructors to include active learning elements without sacrificing course content is called the "classroom flip" or the "inverted classroom." [5] The classroom flip utilizes the internet to place substantial amounts of class material online, often in video format as a "virtual lecture." Students are then asked to use out-of-class time to watch the lectures.

Recent technology has made inverting the classroom easier for faculty and more accessible by students. [6] Software programs such as Camtasia Studio, Adobe Captivate, Camstudio, and UltraVNC Screen Recorder, to name a few, allow instructors to record spoken voice and/or video while also capturing on-screen materials such as software demonstrations, worked problems, or PowerPoint slides. In addition, the use of classroom management systems, such as Web CT, Blackboard, and ANGEL, makes the uploading of the class materials easy and secure.

By requiring students to access the "virtual lectures," the instructor can spend valuable class-time leading students in engaging activities without sacrificing time that is needed to cover course content. In the classroom flip method, the role of the instructor shifts. No longer is the instructor the "sage on the stage" in which the primary role is to transmit information during class time. Rather, the student must take initiative during his or her own time to prepare for class. Class-time can then be devoted to other types of activities.[7] 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 if needed.

In order to ensure that students do indeed access the online lectures, instructors need to implement a sort of "gate-check" such as a pre-class quiz that tests students' understanding of the material. These online quizzes serve multiple purposes. First, having online quizzing increases the likelihood that students will use out-of-class time to watch the videos in order to learn the material necessary to be successful in the quizzes. This helps to assure that students will be prepared for the in-class activities. 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. [8]

The classroom flip method may be perceived to be particularly beneficial to students who prefer certain types of learning environments. According to the Felder-Solomon *Learning Styles Index,* students may classify themselves along four dimensions as being a certain type of learner: active/reflective, sensing/intuitive, visual/verbal, and sequential/global.[9,10] The classroom flip allows for a more active engagement, which may be a more conducive learning environment for those students who consider themselves to be active learners. The use of more active methods in

the classroom may also potentially expand the skills of other students who have other types of learning styles.

This paper discusses the use of the classroom flip strategy in an architectural engineering course at Penn State University. Assessment data were collected to explore student perceptions of the classroom flip and to examine how students used the video lectures.

Context of Study

In the spring of 2008, the classroom flip was used in a large undergraduate Architectural Engineering course entitled "Introduction to the Building Industry." The objective of the course is for students to be able to learn and apply methods for organizing and managing construction projects. The course combines business concepts, such as contracting methods and project organization, with problem solving topics like cost estimating and critical path method scheduling. The course enrolls approximately 100 students each semester that it is offered. It consists of two 50-minute lecture periods and one 110 minute practicum weekly.

In 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. Students were open to the use of the recorded lectures, as supported by preliminary assessment data shown in Figure 1. The instructor of the course wanted to take the next step and flip the course for a variety of reasons. First, the availability of online lectures would allow students to be exposed to theory-based content outside of class time. Taking the lecture out of class would allow greater time for in-class problem solving and increase the opportunity for increased teacher-student interaction. In addition, the use of the practicum period, which had previously been used to deliver course content, could be used for students to work on group projects, with the instructor available for assistance and guidance.

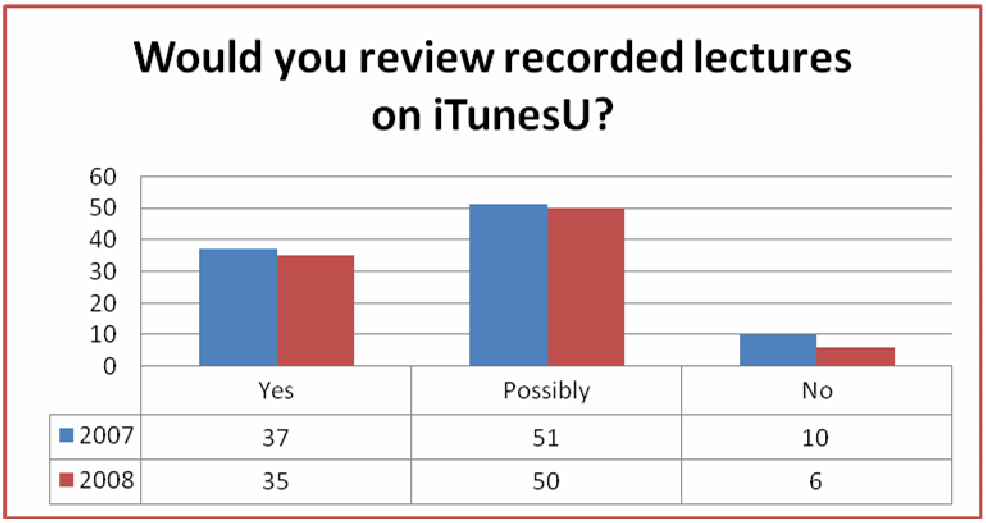

Figure 1: Feedback regarding the interest in the use of iTunesU for posting lecture content.

The classroom flip method was used for cost estimating, one of three main topics in the course. Having the iTunesU video content from the 2007 offering of the course enabled the instructor to take the previous year's lecture content, edit the video to provide specific course content, and

post the videos for students to watch before attending class. To help ensure that the students watched the posted videos, online quizzes were utilized. The method was piloted with one lecture topic well in advance of the cost estimating topics to ensure students could access the video and to test the process of editing, posting, and providing access to the video. The first video was 50 minutes in duration; the other videos for the estimating topics were shortened to 25 to 30 minutes each based on feedback from students. The online quizzes and videos were made available to the students, who were then expected to watch the video and read any related materials from the text in preparation for taking the quiz and attending the class. Videos were not posted in advance of every lecture period, but were used typically once per week to match sub-topics for the section of the class focused on cost estimating. In addition, extra examples problems and solutions, which were not covered in class, were provided as additional video-recordings.

Research Questions

Two broad research questions were addressed for this study, which are described further below.

1. How did students use the video lectures?

Student success in active learning examples in the flipped classes depends on students' level of preparation for class. If students do not use out-of-class time to watch the videos, they will be unlikely to succeed on the in-class exercises. One concern that some instructors may have with the classroom flip is whether or not students will access the video lectures. Therefore, part of this study examined students' self-reported behaviors regarding video lectures, including the frequency of watching the videos, frequency reviewing the videos, and the amount of time spent watching the videos. This data addressed the question of how students used the videos.

2. What are students' perceptions of the classroom flip?

A second area of exploration for this study focused on students' perceptions of the classroom flip in regards to their learning. Data was collected to answer questions such as: Do students prefer the technique over traditional learning? What were the challenges of participating in the flipped classes as compared to traditional lectures?

Data Collection

Assessment data was collected at several points of time during the semester. First, a minute paper was given following the piloted flipped class session. Students were simply asked to state what they liked and did not like about the classroom flip. The minute paper was given during class time on pencil and paper. The information from this short minute paper was coded and used to create two longer surveys.

Following six flipped class sessions, a longer course survey was administered to the students. This survey (Course Survey 1) consisted of 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 periods. The information from this survey was used for both summative and formative purposes. In other words, the information was used to both understand students' perceptions of the classroom flip and to guide changes to the method with the intention of maximizing student learning.

An additional course survey was administered to the students at the end of the semester. This survey (Course Survey 2) was used as a summative evaluation of the classroom flip method. The survey consisted of 35 items across 5 subscales in which students were asked to rate their level of agreement. The subscales were intended to measure student perceptions of: 1) the effectiveness of video content, 2) pre-class material (videos versus reading), 3) online quizzes, 4) in-class delivery of material, and 5) the use of the practicum to work on projects. Student responses were coded from 1 to 5, with strongly disagree representing a 1. Averages and standard deviations were calculated for each item. Both of the course surveys were administered online via the university's course management system.

Copies of these surveys are available in Appendix A. Both surveys were developed by the authors in order to gather specific student perception data. Because the surveys were tailored specifically to assess the course innovation, psychometric evidence is not currently available to support the reliability and validity of the instruments.

Results

Of the 95 students enrolled in the course, approximately 80% were male with less than 10% minority representation. A total of 77 students completed the Course Survey 1 and provided consent for their data to be used for research purposes. The response rate for this survey was 80.2%. A total of 80 students responded to Course Survey 2 and provided consent. The response rate for this survey was 83.3%. Select results from Course Survey 1 are displayed in tables below. In addition, Appendix B displays the frequency data and descriptive statistics for the rating scale items from Course Survey 1. Appendix C displays the frequency data and descriptive statistics for all items administered during Course Survey 2.

How do students use the video lectures?

The overwhelming majority of the students reported watching each video that was available online. Most students (92%) reported watching the video one time, although many students reported reviewing unclear portions of the video. Figure 2 displays the frequency distribution of the number of students who reviewed unclear portions.

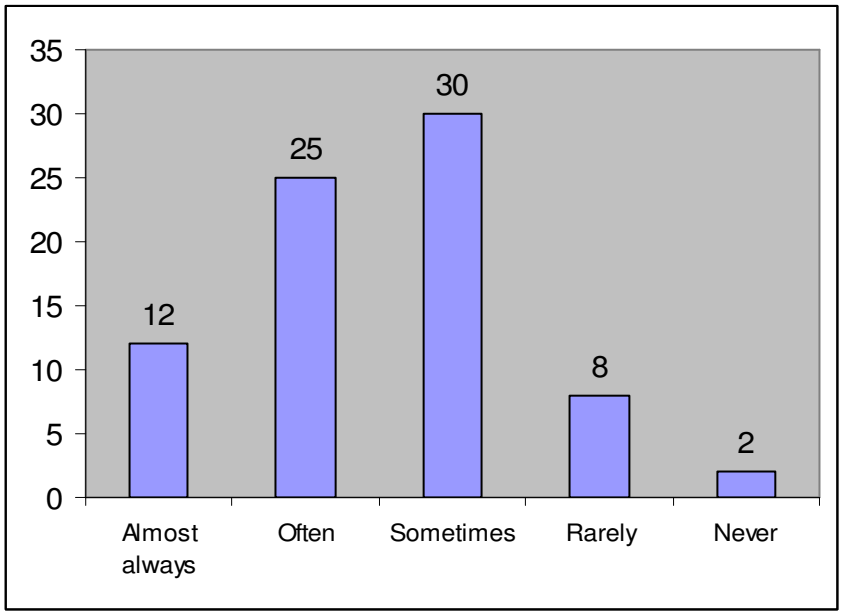

Figure 2: Number of students reviewing unclear portions of the video

The majority of the students reported watching the videos either straight through (36.4%) or straight through with review of unclear pieces (53.5%). Most students spent either 30 or 45 minutes watching the lectures in one sitting. Over half of the students thought that the optimum length of posted lectures was 20 minutes (59.5%), though having the pilot video length at 50 minutes may have raised the duration students found acceptable. Figures 3 and 4 display the frequency distributions for the time spent watching lectures and the optimum lengths of posted lectures.

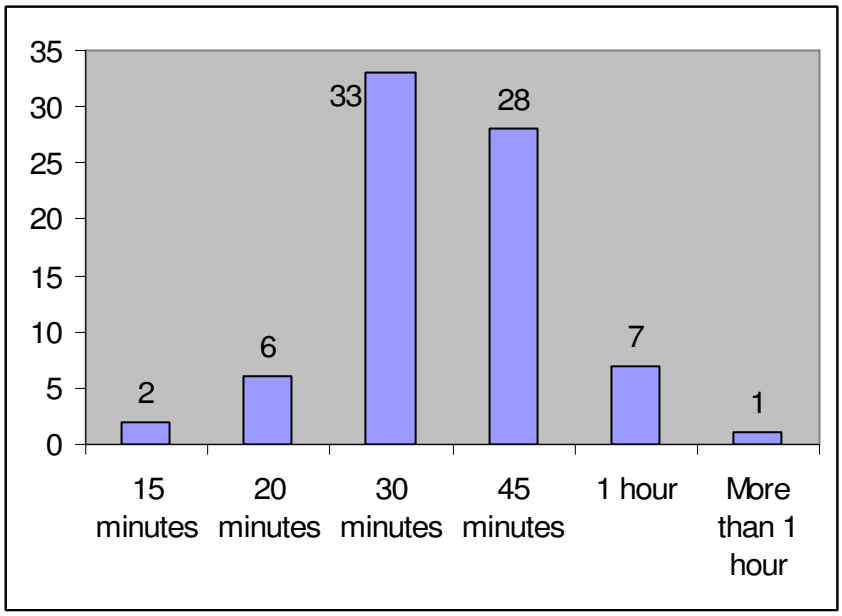

Figure 3: Typical time spent watching video lectures

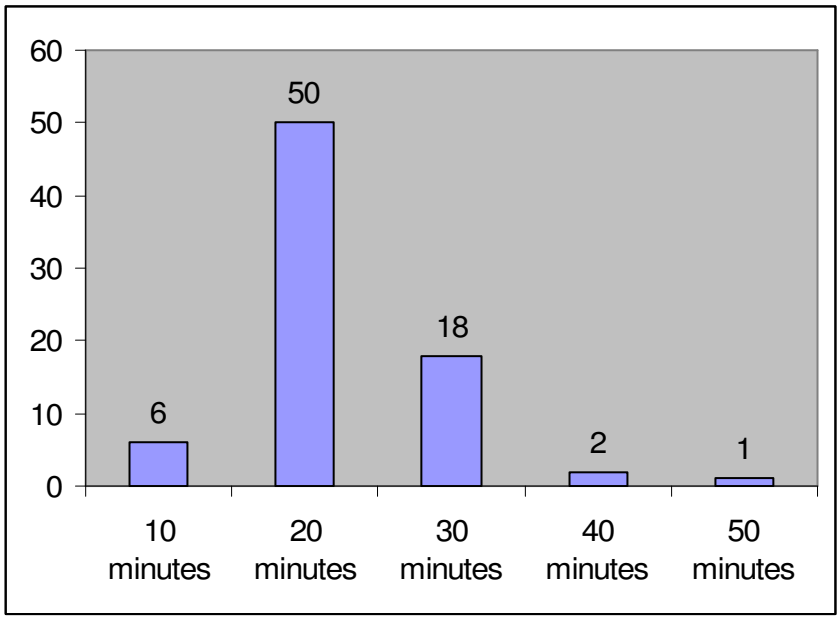

Figure 4: Perceived optimum length of posted lectures

In summary, students were willing to use out-of-class time to watch the videotaped lectures. Many watched portions of the videos multiple times in order to better understand unclear sections. Not surprisingly, students tended to prefer watching videos of a shorter duration.

What are students' perceptions of the classroom flip?

The majority of the students (74%) felt that the flipped classes were helpful to their understanding of the concepts. An additional 24.7% felt that the flipped classes were somewhat helpful. A total of 75.3% of the students agreed or strongly agreed that the additional time spent problem solving in class improved their understanding of the estimating methods.

While the majority of the students found the flipped class periods to be helpful to understanding, the vast majority of the students did not want every class to be held in the inverted format (see Figure 5). Rather, most students felt that the courses should be flipped about half the time. According to 70.1% of the students, the instructors of the course dedicated an appropriate amount of time to the in-class activities (see Figure 6).

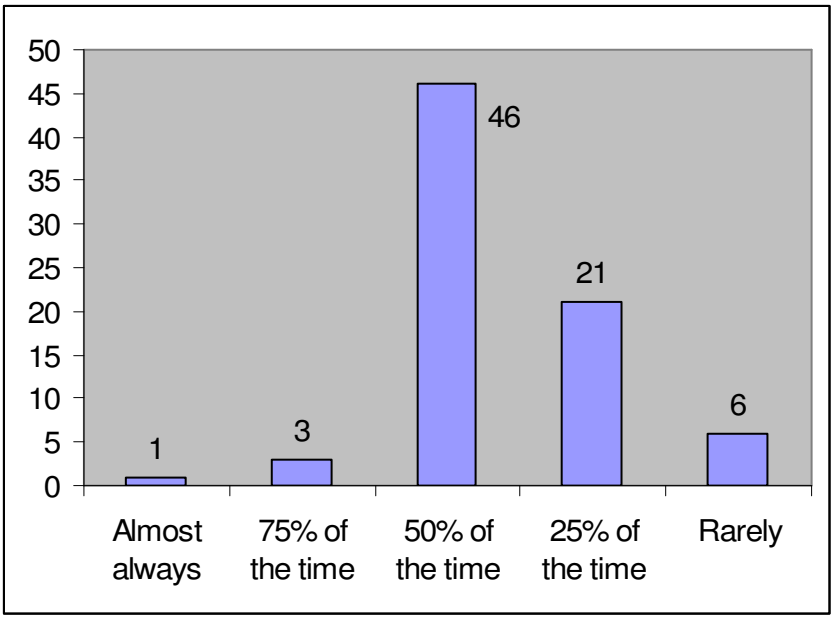

Figure 5: How often students think course should be held in the flipped format

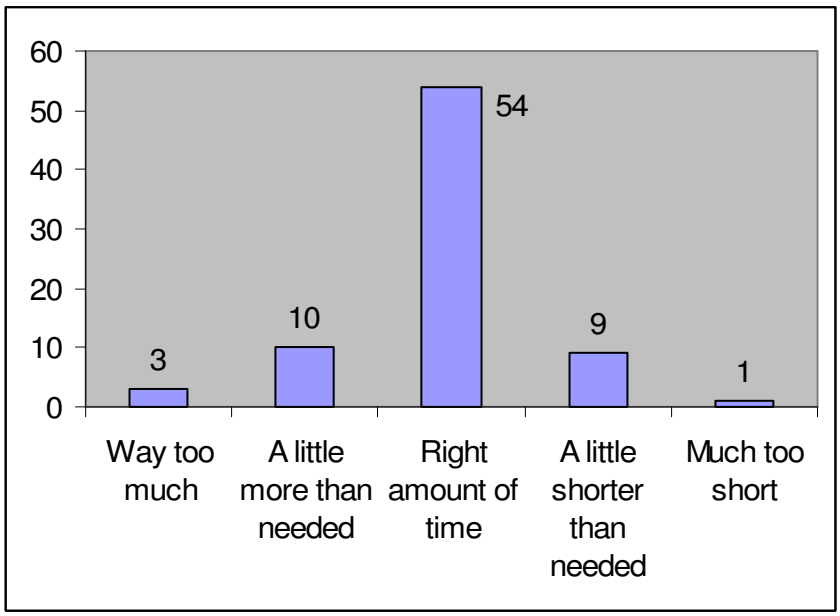

Figure 6: Perceptions of amount of time dedicated to in-class activities

As mentioned above, Appendix B displays the frequency distributions, means, and standard deviations for rating scale items included on Course Survey 1. Approximately half of the students preferred to listen to a lecture face-to-face, rather than watching the lecture on video. However, only 20% felt that they had a difficult time following the video content. Approximately half the students felt that it was easy to get distracted while listening to the video lecture.

Data collected after the six flipped class sessions showed that 76.6% of the students felt that more time needed to be spent at the beginning of the class for review. The instructor made

changes to the course so that a short review was used to remind student of the video content and prepare them for the in-class activities. By the end of the semester, a total of 68.8% of the students said that the video reviews at the start of class helped the transition to the in-class exercises. In addition, the overwhelming majority of the students (91.3%) said that they understood the in-class exercises better when an example was shown at the start of the class.

Students were asked whether they preferred watching the videos as a way to prepare for class, rather than reading a textbook. Students rated the usefulness of both the textbook and the videos similarly. As shown by the data in Appendix C, a total of 43.6% of the students thought that the videos were a more effective delivery than the textbook (41% were uncertain). Over half of the students (52.6%) felt that the videos allowed them to "sit back and absorb the material."

On Course Survey 2, students were also asked about their perceptions of the practicum for group projects. A total of 78.8% of the students felt that the use of the practicum for the group projects was a good use of time. In addition, 61.3% of the students thought that using the practicum for the group projects made it worth having to watch the videos outside of class. A total of 90.1% thought that having the instructor and teaching assistant present during the practicum helped understanding of how to perform well on the project.

Summary and Discussion

The classroom flip experiment in the architectural engineering course had generally positive reactions from the students. Students thought that flipping the classes led to increased understanding of the subject material and assigned projects. Students reported watching the videos outside of class, as their homework assignment. The instructor of the course has decided to continue using the model in future semesters, given the results of the assessment.

While the experiment was judged to be a success, the assessment results did yield some suggestions for others who may want to try the method. First, the students desire that the videos be kept somewhat short. The students were less willing to watch videos that were an hour long. Rather, they desired to have videos around 20 minutes in length. A second suggestion for instructors would be to briefly review the course content before in-class activities begin during class periods. This brief review serves as a refresher for course material similar to how one might highlight content from an assigned reading and allows for emphasis of the most important course concepts, and provides students the opportunity to ask questions. The goal of this refresher should not be to replicate all the information from the video, but rather to be a brief reminder of the course material so that students will be better able to complete the in-class activities successfully. In addition, the review allowed the instructor to see where students had difficulty and watch for signs of confusion, which would only be possible in the live classroom setting.

The instructor of the course often had included short example problems during his review. Another possibility would be to ask the students to complete these examples online for a homework assignment, in order to reduce the possibility that students were relying on the instructor reviews to gather a basic understanding of the material rather than watching the videos on their own time.

In summary, the authors suggest the following recommendations for other instructors who would like to attempt the classroom flip technique in their own class:

1. Require students to complete an online quiz before students come to class as a "gate-check" to make sure that they are prepared.
2. Keep the videos relatively short (no longer than 20-30 minutes) in order to ensure that students watch them.
3. Briefly review the course content before in-class activities to answer any questions and to make sure that the majority of the students have sufficient understanding of the material.
4. Consider adding multi-media to the online lectures in order to keep students interested and engaged in the material.

This study does have several limitations. First, no control or comparison groups were available to compare the impact of the course changes. Second, the instruments developed for the survey were tailored to the specific course changes by the authors. While tailor-made surveys allow for the assessment of very specific course innovations, they lack evidence for validity of the instrument. Future investigations need to be performed in order to gather information to support the reliability and validity of the instruments used in this study.

Future research is being conducted to better understand the impact of the classroom flip. Additional data has been collected from the students to understand the relationship between student preferences for the inverted classroom and their learning styles. This work will answer questions such as do students with active learning styles have a more positive perception of the method. In addition, an investigation into the impact of the flipped classes on student learning is necessary. This paper focuses on the students' perception of the flipped classes. While students stated that the instructor's use of the method helped their understanding, research needs to be done to examine the impact on direct measures of student learning, such as course assignments, tests, and project grades. These areas will be explored in future research.

The classroom flip method is a useful way to add active learning to the classroom without sacrificing valuable class time needed for coverage of content. Students are given the responsibility of independently learning the course material so that more class time can be dedicated towards problem solving and active learning exercises. The potential exists for instructors in many disciplines to apply the method, using class time for a variety of different types of exercises. In addition, while the flip technique is described here for a face-to-face setting, the potential exists for the technique to shape blended learning environments.

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APPENDIX A: Student Surveys

Student survey #1 (Administered after first flipped class session)

1. Did you like the classroom flip technique? Yes/No/Yes, but…
2. What suggestion(s) do you have for improving it?

Student survey #2 (Administered after 6 flipped class sessions)

1. Did you watch the recorded lecture as assigned?
2. How many times did you typically watch the lectures?
3. Did you review portions of the lecture that seemed unclear?
   (Almost always, Often , Sometimes, Rarely, Never)
4. Did you watch the video straight through, or watch it in pieces and take breaks?
   (Straight through, Pieces, Straight through, then reviewed unclear pieces, All in one sitting, but I would pause and review certain sections)
5. How long did you typically spend watching the lectures at one sitting?
   (10 mins, 15 mins, 20 mins, 30 mins, 45 mins, 1 Hour, More than 1 hour)
6. What length of posted lectures would you find optimum?
   (10 mins, 20 mins, 30 mins, 40 mins, 50 mins, 1 hour)
7. The amount of time dedicated to in class activities was:
   (Way too much, A little more than needed, Right amount of time, A little shorter than needed, Much too short)
8. Did you find the time spent in class helpful to your understanding of the concepts?
   (Yes, Somewhat, No)
9. Please explain what you found most valuable.
10. How often do you think AE 372 classes should be held in this format?
    [Almost always, Often (75% of the time), Half the time (50/50), Sparingly (25% of the time), Rarely]

11. Please rate how much you agree with the following statements (Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

    a. I prefer to listen to a lecture face-to-face.
    b. I had a difficult time following the video content.
    c. It was easy to get distracted when listening to the video lecture.
    d. Too much time was dedicated to the in-class activities.
    e. I prefer using class time for problem solving activities, rather than listening to a lecture.
    f. My understanding of the estimating methods was improved because of the additional time spent problem solving in class.
    g. I felt prepared to complete problems in class after listening to the video content.
    h. I feel that moving lecture material out of class and having more time to work in groups in practicum is a beneficial use of course time.
    i. The examples from last years' lectures by [the instructor] were easier to follow than the examples [the teaching assistant] taped with updated information.
    j. I feel that more time needs to be spent at the beginning of class reviewing the video content.
    k. I feel that estimating was a good topic for using this format.

Student survey #3 (Administered at end of semester)

Students rated the following statements using the scale: Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, and Strongly Agree.

Effectiveness of video content:

1. The iTunesU videos were effective for introducing new concepts

2. The iTunesU videos were effective for showing examples

3. The iTunesU videos were enjoyable to watch .

4. The iTunesU videos were used too often at one time.

5. The resolution of the videos was appropriate for theoretical concepts.

6. The resolution of the videos was appropriate for showing examples.

7. The iTunesU videos should continue to be used to deliver theory based course material.

8. The iTunesU videos should continue to be used to deliver examples and solutions.

9. The iTunesU videos should be used to deliver supplemental course material, such as content from guest speakers.

Preclass delivery - Videos & Reading:

10. The textbook is a useful reference for class.

11. The iTunesU videos are a useful reference for class.

12. The iTunesU videos were easier to watch than reading the textbook.

13. The textbook serves as a better introduction to the course material than the iTunesU videos.

14. The iTunesU videos serve as a more effective delivery of the material than the textbook.

15. It is quicker to watch a 30 minute video than read a chapter of the textbook.

16. I would rather read the textbook than watch the iTunesU videos.

17. Watching the videos lets me sit back and absorb the material as it is presented.

18. Reading the textbook makes me feel more involved in the material as I learn it.

Online Quizzes:

19. The online quizzes were beneficial for my understanding of the course material.

20. I would have watched the iTunesU videos if we were not required to take quizzes on the material.

21. I would have read the textbook readings if we were not required to take quizzes on the material.

22. I think there were too many quizzes.

23. I think the quiz content should have focused on the iTunesU video content.

24. I think the quiz content should have focused on the textbook content.

25. I think the quiz content should be split evenly between the textbook and iTunesU video content.

In class delivery of material:

26. The recent introductions and reviews of videos at the start of class have helped me transition to the class exercises.

27. The introductions should go into more detail of the video content.

28. The introductions should be briefer and just highlight the key items from the videos.

29. The in class examples are more beneficial than the examples on the iTunesU videos.

30. I understand the in class exercises better when we go through an example at the start of class.

31. I would rather have the class exercises handed in as assignments than take the quizzes online.

Use of practicum time:

32. The use of practicum for group projects is a good use of practicum time.

33. The use of practicum for group projects is worth having to watch the iTunesU videos outside of class.

34. Having the instructor and TA available while we work on projects during practicum is helpful to our understanding of how to perform on the project.

35. Having the TA and instructor available is more important at the beginning of the project to help us get started.

APPENDIX B: Frequency and descriptive data for rating scale items in Course Survey 1 (ranked by item mean)

Item	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Mean (Standard Deviation)	Standard error of mean
My understanding of the estimating methods was improved because of the additional time spent problem solving in class.	3 (3.9%)	1 (1.3%)	15 (19.5%)	39 (50.6%)	19 (24.7%)	3.90 (0.97)	0.10
I feel that more time needs to be spent at the beginning of the class reviewing the video content.	1 (1.3%)	6 (7.8%)	11 (14.3%)	47 (61.0%)	12 (15.6%)	3.82 (0.84)	0.09
I prefer to listen to a lecture face-to-face.	1 (1.3%)	5 (6.5%)	33 (42.9%)	27 (35.1%)	11 (14.3%)	3.55 (0.87)	0.10
I feel that moving lecture material out of class and having more time to work in groups in practicum is a beneficial use of course time.	2 (2.6%)	10 (13.0%)	19 (24.7%)	41 (53.2%)	5 (6.5%)	3.48 (0.90)	0.10
It was easy to get distracted when listening to the video lecture.	4 (4.8%)	15 (19.5%)	20 (26.0%)	23 (29.9%)	15 (19.5%)	3.39 (1.16)	0.13
I prefer using class time for problem solving activities, rather than listening to a lecture.	5 (6.5%)	7 (9.1%)	28 (36.4%)	32 (41.6%)	5 (6.5%)	3.32 (0.97)	0.11

Item	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Mean (Standard Deviation)	Standard error of mean
I felt prepared to complete problems in class after listening to the video content.	3 (3.9%)	16 (20.8%)	20 (26.0%)	34 (44.2%)	4 (5.2%)	3.25 (1.01)	0.11
I had a difficult time following the video content	10 (13.0%)	26 (33.8%)	26 (33.8%)	12 (15.6%)	3 (3.9%)	2.64 (1.025)	0.11
Too much time was dedicated to in-class activities	5 (6.5%)	38 (49.4%)	25 (32.5%)	5 (6.5%)	4 (5.2%)	2.55 (0.91)	0.10

APPENDIX C: Frequency and descriptive data for rating scale items in Course Survey 2 (ranked by item mean)

Item	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Mean	Standard Dev.	Standard Error of Mean
I understand the in-class exercises when we go through an example at the start of class.	0	1 (1.3%)	6 (7.5%)	42 (52.5%)	31 (38.8%)	4.29	0.66	0.07
Having the instructor and the TA available while we work on projects during practicum is helpful to our understanding of how to perform on the project.	2 (2.5%)	2 (2.5%)	4 (5.0%)	37 (46.3%)	35 (43.8%)	4.26	0.87	0.10
Having the TA and the instructor available is more important at the beginning of the project to help us get started.	1 (1.3%)	2 (2.5%)	10 (12.5%)	37 (46.3%)	30 (37.5%)	4.16	0.83	0.09
The use of practicum for group projects is a good use of practicum time.	3 (3.8%)	7 (8.8%)	7 (8.8%)	31 (38.8%)	32 (40.0%)	4.03	1.09	0.12
The in-class examples are more beneficial than the examples on the iTunesU videos.	1 (1.3%)	6 (7.5%)	15 (18.8%)	33 (41.3%)	24 (30.0%)	3.88	1.05	0.11
The use of practicum for group projects is worth having to watch the iTunesU videos outside of class.	5 (6.3%)	10 (12.5%)	16 (20.0%)	27 (33.8%)	22 (27.5%)	3.64	1.19	0.13
The recent introductions and reviews of videos at the start of the class have helped me transition to the class exercises.	4 (5.0%)	9 (11.3%)	12 (15.0%)	44 (55.0%)	11 (13.8%)	3.61	1.03	0.12
The iTunesU videos are a useful reference for class.	1 (1.3%)	8 (10.0%)	14 (17.5%)	47 (58.8%)	8 (10.0%)	3.59	1.02	0.96
The textbook is a useful reference for class.	1 (1.3%)	4 (5.0%)	22 (27.5%)	46 (57.5%)	5 (6.3%)	3.55	0.93	0.08
The iTunesU videos should be used to deliver supplemental course material, such as content from guest speakers.	2 (2.5%)	9 (11.3%)	23 (28.8%)	38 (47.5%)	8 (10.0%)	3.51	0.91	0.10
The resolution of the videos was appropriate for theoretical concepts.	3 (3.8%)	11 (13.8%)	18 (22.5%)	39 (48.8%)	9 (11.3%)	3.50	0.99	0.11

Item	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Mean	Standard Dev.	Standard Error of Mean
The introductions should go into more detail of the video content.	1 (1.3%)	9 (11.3%)	23 (28.8%)	38 (47.5)	8 (10.0%)	3.50	0.96	0.10
The iTunesU videos were easier to watch than reading a textbook.	3 (3.8%)	11 (13.8%)	23 (28.8%)	27 (33.8%)	14 (17.5%)	3.40	1.19	0.12
The online quizzes were beneficial for my understanding of the course material.	2 (2.5%)	12 (15.0%)	18 (22.5%)	44 (55.0%)	3 (3.8%)	3.39	0.96	0.10
It is quicker to watch a 30-minute video than read a chapter of the textbook.	2 (2.5%)	13 (16.3%)	23 (28.8%)	28 (35.0%)	12 (15.0%)	3.36	1.15	0.12
The iTunes U videos were effective for introducing new concepts.	4 (5.0%)	15 (18.8%)	16 (20.0%)	38 (47.5%)	7 (8.8%)	3.36	1.05	0.12
Watching the videos lets me sit back and absorb the material as it is presented.	2 (2.5%)	14 (17.5%)	21 (26.3%)	33 (41.3%)	8 (10.0%)	3.31	1.11	0.11
The iTunes U videos were effective for showing examples.	6 (7.5%)	12 (15.0%)	22 (27.5%)	31 (38.8%)	9 (11.3%)	3.31	1.10	0.12
The iTunesU videos serve as a more effective delivery of the material than the textbook.	3 (3.8%)	9 (11.3%)	32 (40.0%)	27 (33.8%)	7 (8.8%)	3.25	1.06	0.11
I think the quiz content should be split evenly between the textbook and the iTunesU video content.	2 (2.5%)	18 (22.5%)	26 (32.5%)	27 (33.8%)	7 (8.8%)	3.24	0.98	0.11
The iTunesU videos should continue to be used to deliver theory based course material.	6 (7.5%)	13 (16.3%)	23 (28.8%)	33 (41.3%)	5 (6.3%)	3.23	1.04	0.12
I think the quiz content should have focused on the textbook content.	3 (3.8%)	14 (17.5%)	32 (40.0%)	27 (33.8%)	4 (5.0%)	3.19	0.92	0.10
The iTunesU videos should continue to be used to deliver examples and solutions.	10 (12.5%)	14 (17.5%)	17 (21.3%)	34 (42.5%)	5 (6.3%)	3.13	1.16	0.13
The iTunes U videos were used too often at one time.	1 (1.3%)	20 (25.0%)	28 (35.0%)	26 (32.5%)	4 (5.0%)	3.11	1.00	0.10
I would have read the textbook readings if we were not required to take quizzes on the material.	5 (6.3%)	22 (27.5%)	22 (27.5%)	26 (32.5%)	5 (6.3%)	3.05	1.05	0.12

Item	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Mean	Standard Dev.	Standard Error of Mean
I would have watched the iTunesU videos if we were not required to take quizzes on the material.	6 (7.5%)	18 (22.5%)	29 (36.3%)	22 (27.5%)	5 (6.3%)	3.03	1.03	0.12
I think the quiz content should have focused on the iTunesU video content.	3 (3.8%)	24 (30.0%)	27 (33.8%)	23 (28.8%)	3 (3.8%)	2.99	0.95	0.11
Reading the textbook makes me feel more involved in the material as I learn it.	6 (7.5%)	18 (22.5%)	28 (35.0%)	24 (30.0%)	2 (2.5%)	2.90	1.07	0.11
The textbook serves as a better introduction to the course material than the iTunesU videos.	1 (1.3%)	22 (27.5%)	35 (43.8%)	19 (23.8%)	1 (1.3%)	2.89	0.91	0.09
The resolution of the videos was appropriate for showing examples.	8 (10.0%)	26 (32.5%)	18 (22.5%)	26 (32.5%)	2 (2.5%)	2.85	1.07	0.12
The introductions should be briefer and just highlight the key items from the video.	6 (7.5%)	26 (32.5%)	28 (35.0%)	15 (18.8%)	5 (6.3%)	2.84	1.02	0.12
I would rather read the textbook than watch the iTunes videos.	7 (8.8%)	29 (36.3%)	22 (27.5%)	18 (22.5%)	2 (2.5%)	2.66	1.08	0.11
The iTunes U videos were enjoyable to watch.	13 (16.3%)	19 (23.8%)	33 (41.3%)	14 (17.5%)	1 (1.3%)	2.64	1.00	0.11
I would rather have the class exercises handed in as assignments than take the quizzes online.	12 (15.0%)	34 (42.5%)	15 (18.8%)	11 (13.8%)	8 (10.0%)	2.61	1.20	0.13
I think there were too many quizzes.	3 (3.8%)	38 (47.5%)	36 (45.0%)	2 (2.5%)	1 (1.3%)	2.50	0.67	0.08