Investigation of Student Achievement and Attitude about a Flipped Classroom Using Linked Lecture Videos in Biomedical Engineering (Work in Progress)

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Dr. Caplan teaches several classes including Biotransport Phenomena, Biomedical Product Design and Development II (alpha prototyping of a blood glucose meter), and co-teaches Biomedical Capstone Design. Dr. Caplan also conducts educational research to assess the effectiveness of interactive learning strategies in large classes (˜150 students).

Work in Progress: Investigation of Student Achievement and Attitude about a Flipped Classroom using Linked Lecture Videos in Biomedical Engineering

Introduction

The use of technology in the university classroom continues to rise as made evident by the use of online interfaces for homework, clicker questions, and electronic grade centers. Courses are now offered in other formats, such as hybrid, flipped, and online. In a flipped classroom, the lectures are watched by the students outside of class before the next scheduled class, which requires students to take greater responsibility for their own learning. In return, this creates time during the class period for problem solving and also increases interaction between students and the instructor. This pedagogy is particularly useful for addressing the outcomes required by the Accreditation Board for Engineering and Technology (ABET) as it is difficult to address some of the criteria in a traditional setting, such as the ability to identify, formulate, and solve engineering problems and effectively communicate [1].

Although the number of flipped, engineering classrooms is growing across the country, there is limited research on the impact of flipped classrooms in terms of student achievement and motivation in engineering at the university level [2]. However, there are studies that have shown that video lectures outperform in-person lectures, specifically those that are interactive and require higher level thinking [1]. There are also studies that suggest learning retention is increased with the flipped classroom method in comparison to traditional lectures [3]. After taking a flipped course, students generally would prefer to take another flipped course due to the ability to re-watch lectures and ask instructors and peers questions regarding class content [4].

In this study, we aim to address some of the uncertainties of a flipped classroom by implementing a new lecture format in Transport Phenomena. Transport Phenomena is a junior level biomedical engineering course originally flipped in Spring 2013. Since transitioning to a flipped classroom, students have been required to watch 75-minute lectures outside of class where the instructor covered key concepts and examples using paper and marker on a document camera. In class, students then worked in groups to solve problems with instructor and teaching assistant feedback. Students also completed self-graded homework with the opportunity to earn lost points back by discussing fundamental misconceptions. The purpose of this study is to determine the effectiveness of newly created mini lectures with integrated questions and links in terms of student achievement and attitude [interest, utility, and "cost" (time, effort, and emotion)].

Methods

The first two lectures were re-formatted to have multiple mini (~15 minute) lecture videos, and 10-30 minute tutorial-based example problem videos. In the mini lectures, the instructor uses slides to outline objectives and concepts which are then filled in with derivations and examples throughout the video. Superimposed in the corner of these slides is the video of the instructor. In the tutorial example videos, a student works side-by-side with the instructor to solve problems, often stopping to discuss unclear concepts. Similar to the mini lectures, video of the instructor and student are superimposed on the slide where the example is being solved. Time to create and deliver these lectures is similar to preparation in the traditional classroom as university services edit and make videos available to the students. The material in the re-formatted lectures corresponds to the original video lectures with the only change being the delivery format.

Students were assigned randomly into four groups at the beginning of the semester. Two of the groups (1 & 2) watched the new lectures, and two of the groups (3 & 4) watched the original

75-minute lectures (n_1=14, n_2=16, n_3=15, and n_4=17). Groups 1 and 4 took version A for the pre-test, and version B for the post-test; whereas, groups 2 and 3 took version B as the pre-test and version A as the post test. Each quiz had four questions regarding content presented in both of the video lecture formats. After completing the pre-test students were directed to watch the first lecture, or set of lectures, and then return to take the post quiz. After completing the second post-quiz, students were asked to complete the attitudinal survey to assess student motivation and time spent as well as provide comments. Students that watched the video before taking the pre-test or did not watch the video prior to the post-quiz were excluded from the study results. Further, only results from those who consented according to an IRB-approved protocol were analyzed.

Results

The average Hake Gain was calculated for each lecture style for both lectures as shown in Figure 1. There was no significance in gain between lecture styles, indicating there was no statistically significant decline in performance with the shorter mini lectures in comparison to the traditional longer lectures.

Although the results in gain were very similar, student attitude towards the new mini lecture format was more positive, as seen in Table 1 and Table 2.

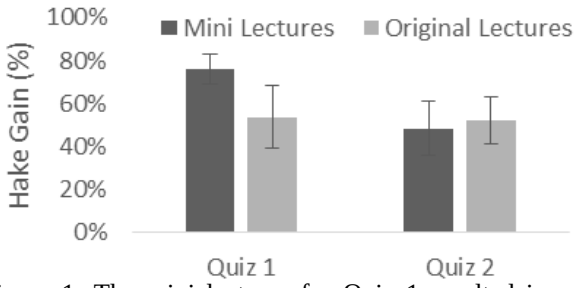

Figure 1: The mini lectures for Quiz 1 resulted in an average Hake gain of 76% compared to 54% for the original lectures. For Quiz 2, the mini lectures had an average Hake gain of 49% compared to 52% for the original lectures (error bars = standard deviation).

Table 1. Student responses when asked if they would like to see the videos used in other courses.

Statement: I would like to see the video lectures used in other courses				
	Completely agree	Agree more than disagree	Disagree more than agree	Completely disagree
Mini Lectures	40%	40%	20%	0%
Original Lectures	16%	32%	44%	8%

Table 2. Student Responses when asked if they thought the lectures required too much time to watch

Statement: The video lectures used in this course required too much time				
	Completely agree	Agree more than disagree	Disagree more than agree	Completely disagree
Mini Lectures	5%	10%	45%	40%
Original Lectures	37%	40%	20%	3%

Of the 48% of students in the original lecture groups that agreed they like to see these used in other courses, 60% watched the new lecture format after and found them to be clearer and the objectives easier to understand. As shown in Figure 2, when asked if students felt that the lecture videos motivated them to do well in the course, 95% of students who watched the mini lectures completely agreed or agreed more than they disagreed. The students in the groups that watched the longer traditional lectures were asked the same question, and only 52% completely agreed or agreed more than they disagreed.

Three of the students assigned to the original lecture groups indicated in the attitudinal survey comments that they had watched the mini lecture videos after completing the final quiz.

These students felt the videos had clearer learning objectives and higher video quality, leading to less frustration with the video. All three students shared they would like to see more of the mini lecture videos implemented into the course as they were able to understand the topics and equations more clearly. These results suggest that increased student motivation will continue if the rest of the material is re-flipped.

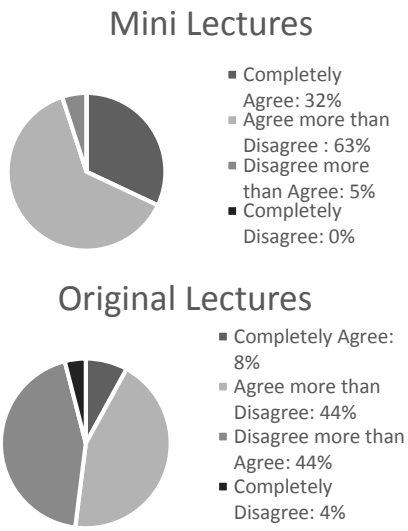

Figure 2: Responses from students when asked if they felt that the lecture videos motivated them to do well in the course.

Discussion

Future work includes integrating the mini lectures and tutorial videos into an interactive platform called PlayPosit. The videos will include embedded questions every few minutes and links to Muddiest Point videos to allow for customizable instruction as well as formative feedback on important concepts. Following integration of PlayPosit, we will repeat the pilot study with a larger sample size and track data on student interaction with the video links, student achievement, and student attitude.

Another aspect of the study we would like to examine is student achievement throughout the entire semester with the new lecture format. We would like to see if there is a correlation between the pre and post quizzes and exam scores, and then how this motivation continues throughout the semester. We will compare the results from students in the course that watched the new videos and those in the same course that watched the original lectures. We hypothesize that students who watch the mini interactive lectures will have increased motivation and desire to do well in the course and will understand the foundational topics of the course more thoroughly.

Conclusions

This study showed no decline in performance with the shorter mini lectures and moreover, showed that student attitude towards the new videos was more positive. The students that watched the mini lectures felt more motivated to do well in the course than those who watched the original lectures. Additionally, the students that watched the mini lectures also agreed that the videos did not require too much time or effort; whereas, the students in the original 75-minute lecture groups felt the videos did take too much time and effort to watch. The study will be continued to look at the effect of the interactive platform with pop-up links and integrated questions on student achievement and attitude.

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