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Asynchronous Peer-to-Peer Learning: Putting Student Projects to Work in Future Classes

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ABSTRACT

For instructors interested in flipping their courses or using in-class video introductions to new topics, the development of custom video lecture content can be a daunting task. Having students create videos as a term project creates the potential opportunity to engage students in peer-to-peer learning via videos while also generating course content that could help flip a course over time. In addition to aiding the instructor in course content generation, the project helps the student creators learn the video content, as indicated by the literature. This paper explores the effectiveness of resulting asynchronous peer-to-peer video content at facilitating student learning amongst the students enrolled in a Construction Estimating course from four semesters of implementation. Pre- and post- video presentation quiz scores were analyzed to verify an overall statistically significant increase in student quiz performance for the majority of the video projects whether used in class to introduce a new topic during the semester or during the end-of-semester presentation day for new projects. Thus, this study shows the promise of student-produced videos as course content, especially for those instructors seeking to flip or partially flip their course. Additionally, the paper presents some lessons learned from the implementation of a video project to produce course content.

Key words: Peer Instruction; Streaming Video; Flipped Classroom

INTRODUCTION

The trend of inverted or "flipped" classrooms is an option for some instructors wishing to spend less class time lecturing and more class time with hands-on or interactive problem-solving activities.

This approach involves students first gaining exposure to course topics outside of the class (e.g., asynchronous video lecture, practice example problems) and, subsequently, allows time inside of the class for hands-on activities, collaborative problem-solving, interactive discussion, and most importantly allows the instructor to work example problems, answer questions, address misconceptions and/or introduce real world applications (Strayer, 2012; Davies et al., 2013; Herreid & Schiller, 2013; Wilson, 2013; Bishop & Verleger, 2013).

One of the authors of this paper was interested in flipping one of their courses and conceived of this study as a way to examine the effectiveness of using student-produced videos to generate the video content needed to eventually flip or partially flip the course. As such, this paper reviews the literature of peer-to-peer learning, learning from creation and consumption of videos, and learning in flipped classrooms, before describing the methodology used to explore peer-to-peer video content that was generated as a term project in which students create videos on course content and develop questions to engage students in asynchronous learning. During this study, video projects from previous semesters were used as introductions to lecture topics at the start of lecture periods. In addition to aiding the instructor in course content generation, the project helps the student creators learn the video content, as indicated by the literature (Forehand, 2005; Allegra, et al., 2001; Beard, 2012; Hammond & Lee, 2009; Ferreri & O'Connor, 2013). This paper further describes the students' video products and examines the effectiveness of asynchronous peer-to-peer video content on student learning as measured through pre- and post-video quizzes. As this paper would be of most interest to other instructors seeking to develop course content from student projects, this paper also discusses lessons learned from the implementation of a video project to produce course content.

BACKGROUND

The premise behind this project was based on literature establishing the effectiveness of three learning environments: peer-to-peer, student creation of video content, and the viewing of video content. This project combined those three environments on the hypothesis that students can successfully engage in asynchronous peer-to-peer learning by watching content-focused videos created by fellow students/classmates.

Peer-to-Peer Learning

Lev Vygotsky's learning theory of social constructivism stresses the importance of social interaction and community interaction for cognitive development (Galloway, 2001; Vygotsky, 1978; Howland, 1969). The main components of this theory involve the More Knowledgeable Other (MKO) who scaffolds the learner's ability to transition from cooperative learning to independent learning, or what is referred to as the learner's Zone of Proximal Development (ZPD). Through an instructor, peer, or, in this case, student-produced educational videos, the MKO acts as a facilitator for the undergraduate students to learn (Galloway, 2001; Vygotsky, 1978). In a direct peer-to-peer setting, the MKO peer presents course content in a way that makes the student learners feel comfortable with the new content and, therefore, students are able to successfully reach their own ZPD. Student-produced videos have the potential to also facilitate undergraduate student learning by allowing the student filmmaker to be an asynchronous MKO and as they attain the ZPD through their video.

In purposefully fostering peer-to-peer learning environments, the instructor transfers some of the responsibility of learning to the students by creating a dependent network between the students (Galoway, 2001; Boud et al., 1999). By increasing student control over their own learning, an increase in their determination and learning at any point (in or out of the classroom) should occur (Boud et al., 1999). Furthermore, in a mixed method study with 82 undergraduate engineering students Nicol, Thomson, and Breslin (2014) reported that students believe they can learn from their peers when the right structure is provided by the instructor.

Learning from Creating Videos

Most of the videos reported in the literature were produced by the course instructor (He, Swenson, & Lents, 2012; Herreid & Schiller, 2013; Jensen et al., 2015; Mavromihales & Holmes, 2016; Pierce & Fox, 2012; Raths, 2014), with few mentions of student productions (Talley, 2013). Developing a course-worth collection of effective videos is also a significant upfront time commitment for an instructor (Jensen et al., 2015). By having students produce video content through class projects, an instructor can build a library of videos that present the material in a variety of styles that, hopefully, can be engaging to the audience. The field of education and instructional design often refers to Anderson and Krathwohl's (2001) Revised Bloom's Taxonomy, which is a modernized update of the Benjamin Bloom's (1956) seminal means of categorizing levels of thinking and learning into lower-order and higher-order thinking skills. When the students make videos, all levels of thinking are used while students are engaged in remembering, understanding, applying, analyzing, evaluating, and creating (Forehand, 2005; Allegra, et al., 2001; Beard, 2012). Additionally, creating digital video is a form of expression that allows students to think creatively and express knowledge with divergent thinking (Bell & Bull, 2010; Schwartz & Hartman, 2007). As such, the student creation of videos on course content topics has been shown to develop as much learning as students acquire through the writing of a term paper (Hammond & Lee, 2009; Ferreri & O'Connor, 2013).

Learning from Watching Videos

When watching a video, whether it is an introduction to a new topic or a review of pre-existing knowledge that a student recalls while viewing, students use low-order thinking skills such as remembering. By engaging the student in remembering previous knowledge and applying new knowledge their pre-existing knowledge is reiterated and retained (Forehand, 2005).

It is understood that videos, through social media outlets such as YouTube, television, and Khan Academy videos, have given students preconceived ideas about asynchronous learning with digital video, yet there is a difference between watching a film for entertainment and watching for learning. When the content being viewed had an actor or person the student can relate to, the content becomes more engaging (Henrich & Prorak, 2010), a finding that encourages the use of student peers in educational videos. Videos are a means of flexibility in various fields of study (Hammond & Lee, 2007; Beard, 2012), such as distance learning students where videos allow students to attend lectures virtually.

Generating Video Content for Flipped Classrooms

Video instruction is also heavily used in the trend of flipped classrooms (He, Swenson, & Lents, 2012; Herreid & Schiller, 2013; Mavromihales & Holmes, 2016; Raths, 2014). For very common course topics, such as Engineering Statics, high quality video content is being developed by textbook manufacturers that is made available to faculty adopting a certain textbook or for a fee (Davies et al., 2013; Pearson, 2015a). Instructors of less common courses, such as Construction Engineering, are on their own to develop video course content for their classes, although textbook manufacturers do offer access to instructional design professionals for a fee (Pearson, 2015b).

The video styles reported in the literature encompass many formats including recordings of in-class lectures, recordings of instructors sitting in their offices lecturing to a camera, and short summaries with a voice recorded over presentation slides, pictures, and texts (McGivney-Burelle & Xue, 2013; Talley, 2013). Most of the videos reported in the literature were produced by the course instructor (Bates & Galloway, 2012; Bergmann & Sams, 2012; Day & Foley, 2006; He, Swenson, & Lents, 2012; Mavromihales & Holmes, 2016; Pierce & Fox, 2012; Raths, 2014; Saterbak, A., Voltz, T., & Wettergreen, 2016; Schroeder, McGivney-Burelle, and Xue; Strayer, 2012; Zhao & Ho, 2014), with few mentions of the use of undergraduate student productions to support flipped classroom instruction (Talley, 2013) although many K-12 teachers employ student-produced tutorial content (Kirch, 2016; Marcos, 2015). The task of generating video-based lecture content for a course can be a huge project that can exceed the time that the instructor has available (Jensen et al., 2015). By having students produce video content through class projects, an instructor can build a library of videos that present the material in a variety of styles that, ideally, can be engaging to the audience. These videos could be used in class to introduce a new topic or assigned to be viewed outside of class in a flipped classroom model.

Impacts of Flipped Classrooms on Student Engagement and Learning

In a meta-analysis, Bishop and Verleger (2013) state that evidence of how flipped classroom instructional models impact student learning at the undergraduate level is still in the early stages with most of the research studies being focused on student perceptions, increased engagement, and attendance. Zhao and Ho (2014) conducted a quasi-experimental study with 98 undergraduate students enrolled in a flipped History class and found that though there was no compelling impact on midterm exam scores, students reported increased engagement from gaining background knowledge of topics via online videos prior to class and that the interactive in-class discussions and hands-on activities enhanced their understanding of content through peer interaction. In the context of undergraduate Statistics, Strayer (2012) compared one section using a flipped classroom model with another section using a traditional lecture model and found that students were initially less comfortable with the aspects of cooperative learning embedded within the flipped classroom model but they ended up favoring the instructional approach at the end of the term. Mavromihales & Holmes (2016) conducted a qualitative study with 100 students enrolled in a Manufacturing Engineering course that used a flipped model and found that increased participation with out-of-class resources was connected to perceptions of success and higher attendance.

There are several studies that demonstrate the advantages flipped classroom instructional models have on student learning via improved scores on assignments, exams, and standardized measurements. Using experimental methods with 46 students enrolled in two sections of a Human-Computer Interaction course, Day and Foley (2006) compared a traditional lecture-based control group with a flipped model experimental group and found that the experimental group reported positive attitudes toward the flipped approach and scored significantly higher grades on homework, projects, midterm, and final exam. Similarly, Schroeder, McGivney-Burelle, and Xue (2015) studied 112 students enrolled multiple sections of Calculus I and found that students in the flipped section scored higher on homework and exams. Bates and Galloway (2012) conducted a mixed methods study of 200 students enrolled in an undergraduate Physics course and found increases in student engagement and evidence for high quality learning with a 54% normalized gain on the widely used Force Concept Inventory and an increase in end-of-course exam scores compared to previous semester cohorts. In a two-year comparison of an engineering course with a traditional section and a flipped section, Mason, Shuman, and Cook (2013) found that the flipped section was able to cover more content and resulted in students performing the same or better on quizzes and exams. Similarly, using mixed methods to compare a traditional and a hybrid flipped course format, Karabulut-Ilgu and Jahren

(2016) conducted a study of 67 undergraduate students in two sections of a Construction Engineering course and found students in the hybrid flipped performed at a significantly higher level. With a slightly different approach, He, Swenson, and Lents (2012) conducted a study in an undergraduate Chemistry course and found that the use of supplemental video tutorials assigned after homework and exams significantly helped the average and lower-performing students to master chemistry concepts as reflected in their grades.

Student productions are no guarantee of success as students do not always make quality content (Kirch, 2016; Marcos, 2015; Talley, 2013), however peer-to-peer learning has been proven to be successful (Boud et al., 1999) so there is reason to believe that student-produced video content can successfully result in student learning within a flipped classroom.

METHOD

Term Project Description

The video project was defined very broadly to encourage creative submissions. Each video was to be two to four minutes in duration and on a topic covered in the course: Construction Estimating. These videos typically aligned with the common learning outcomes of either saying or doing coupled with engagement (Schwartz & Hartman, 2007) as they focus on the recall of facts (saying) or directions for completing a calculation (doing). The videos that presented broad overviews of a topic guided the viewers to recall facts and thus required a lower-order of thinking such as *remembering* and/or *understanding* levels (Anderson, 2005; Forehand, 2005). The more in-depth topics often focused on demonstrating calculations and thus they encouraged a higher-order thinking such as *analyzing* and/or *evaluating* levels (Anderson, 2005; Forehand, 2005). Further, short videos were requested in hopes of holding the attention of the student audience and the two- to four-minute length was envisioned as sufficient to provide either a brief overview of a broad topic or an in-depth example of a narrow topic (Ko & Rossen, 2010; Whatley & Ahmad, 2007; Pressley, 2008; Herder et al., 2002).

The students self-selected their topics from a list provided by the instructor through a first-come, first-served policy. This arrangement allowed the students to select a project meaningful to them while also developing the range of videos needed for the course. Examples of the project prompt and grading rubric that were used during these four semesters are provided in the appendix. The project prompt was purposefully open ended to encourage student creativity in presentation. Except for the first semester, students were also watching videos from previous semesters as introductions to new course content and, thus, they could have been inspired by the previously created videos. Especially because the project prompt was open ended, a grading rubric was provided to the students so they would know how the various elements of the project were weighted prior to creating their videos.

All students had access to the university's computer labs, which provided them with the Microsoft Office and the Adobe Creative suites of software. As such, students had free access to everything they would need to create an animated power point movie and to edit any video that they took on their mobile phones. As a video created in power point can receive equal grades to a video utilizing live action, the access to the ability to create a good project was equitable to all students. Further, as this study was conducted within the classroom setting using student projects, it qualifies for a Category 1 exemption from IRB review.

As this course was co-listed for graduate credit, the project deliverables were different for graduate and undergraduate students. Graduate students would work on their own to produce two videos during the semester: with the first due at mid-term and the second on the last regular class day. As the graduate students worked alone, they were encouraged to use their undergraduate classmates, who received extra credit on their homework grades for their assistance, as helpers or actors for the videos. Video 1 is an example of a graduate student project using undergraduate classmates as the actors. During the first two semesters of the project, only graduate students were assigned the video project. In the third and fourth semesters, undergraduate students were also assigned the project and they worked in teams to produce one video per team that was due at the end of the semester. All students were asked to sign a permission form to allow or decline, at their discretion and without penalty, their projects to be used for educational and research purposes.

Video 1. Graduate Student's Video Project With Undergraduate Actors.

Pre- and Post-Video Quizzes

To accompany each video, the students also wrote three multiple-choice quiz questions that could be answered from watching their videos, which Bates and Galloway (2012) indicate is a useful method in this context. After review by the instructor, these three quiz questions were used as the in-class pre-video and post-video quiz and were intended to be used in future classes for an outside of class pre- and post-video quizzes. The pre- and post-video quizzes were identical so that there would be no influence from the relative difficulty of the questions between these quizzes. This type of assessment strategy allowed the instructor to measure the impact of engaging students in lower-order thinking skills of recall and remembering concepts. The activation of prior knowledge was used in conjunction with newly acquired content knowledge from the instructional videos in order for the students to successfully complete the quizzes. The improvement between the pre- and post-video quizzes was a portion of the project grades to encourage students to take the task seriously, although this area was judged generously. In addition to creating an assessment tool that measured the video's effect on student learning, the quiz question development process was intended to encourage students to be mindful of their video content. Three questions were chosen for the pre- and post-video quiz requirement to be sure the students covered at least three points in their two- to four-minute long videos so that their peers would be able to answer the these questions.

One week prior to the project due dates, students were required to submit their quiz questions so that the instructor could both assemble one pre-/post-quiz featuring three questions per video project and check over the questions for clarity and accuracy. On the project due date, the class took the pre-quiz, watched all of the new video projects being submitted, and then immediately took the post-quiz. Students received extra credit for their performance on the pre- and post-video quizzes on the project presentation day. This arrangement was chosen to incentivize students to do their best on the quiz without penalizing them for confusing or misleading questions and video content.

The results from the end-of-semester project pre- and post-video quizzes were used to identify questions of videos that would need editing before future use. Questions that showed a negative improvement on student learning pre- to post-quiz raised a red flag that editing was needed. As well, if a question came back with a relatively high mean success rate in the pre-quiz, it could be assumed the class had pre-existing knowledge on the topic or the question was too easy. Since this experiment was conducted to look for improvements in students' knowledge after watching videos, questions that were easily answered without having watched a video did not add as much informative value to the collected data. Other than this screening analysis to determine appropriate quiz questions, no experimental controls in the quiz design were put in place. Because of this situation, the authors are forced to assume in the analysis that pre-quiz and post-quiz questions weighed equally in difficulty, and that any difference between quiz scores between pre- and post-video quizzes are a direct result of video learning. As the quizzes were administered immediately before and after the watching of the related video, the assumption that any changes in performance are due to the video seem reasonable as there was not time for the students to consult other resources.

As the database of student-produced videos grew, video projects created in previous semesters (four semesters) were used to introduce lecture topics in subsequent semesters (three semesters). When the video content was used to introduce a new concept during the semester, the pre- and post-video quizzes featuring the three multiple-choice questions for that specific video were administered immediately before and after each video screening. Students received the score of their best effort (pre- or post-quiz) to avoid penalizing current students for any confusing and/or misleading questions or videos. As the video projects from previous semesters were used to introduce new topics, it was expected that the improvement in pre- to post-quiz scores would be higher than in their debut semesters. Therefore, the analysis of these pre- to post-quiz results created the opportunity to test the hypothesis of students learning from asynchronous peer-to-peer learning as well as identifying quiz questions and videos for further refinement. For this scenario of video content being used to introduce a new topic, the students' pre-quiz scores serve as the control population: the typical preparation of students for beginning a new topic. There is an assigned reading for every new lecture topic in the course, as listed on the course syllabus, and it is suspected that many of the students do not read that assignment. If the students can become better prepared for class by watching a video, as evidenced by a higher post-quiz score than their pre-quiz score, than the student-produced video content can show its potential value as a future out of class assignment.

Analytic Procedure

The primary research goal was to evaluate to what extent asynchronous peer-to-peer learning could be accomplished through student-produced videos. In order to measure the effect of the videos, students took identical pre- and post-video quizzes immediately before and after watching the videos. Because students were in the classroom, the quizzes were individual assignments, and the quizzes immediately preceded and followed the video, it was assumed that all increases in quiz performance could be attributed to watching the video. The comparison of pre- to post-quiz scores, therefore, investigated the study's hypothesis: asynchronous peer-to-peer learning can improve student learning.

Results from the projects presented during their debut semester were kept separate for analysis from the results of videos used to introduce a new topic during a subsequent semester. This decision was made because the students' assumed pre-existing knowledge and the classroom atmosphere were substantially different between these two scenarios. When the new videos are being presented as student projects, the students take one combined pre- and post-video quiz for all of the video topics being submitted that day. Further, the students taking the pre- and post-video quizzes on the presentation day made one of the videos, wrote three of the quiz questions, and know all of the other students in the other videos. Presentation day is also the last day of the semester, so all of the students taking the pre- and post-video quizzes during this debut semester have just completed the course that covered the material in the video projects. In contrast, when the videos were used to introduce a new lecture topic, the students were watching a video made by a peer who is not a classmate and that video is on a topic that has not yet been discussed in class, although the students should have completed a reading assignment on the topic.

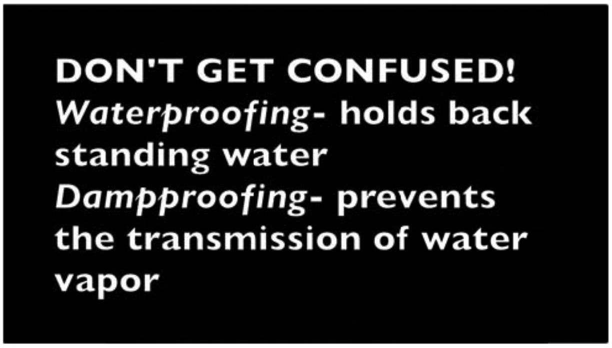
For the scenario of the debut semester, the quiz scores were calculated by video topic rather than for the overall quiz. Each topic had three questions, which were assumed to be of equal weight, and the scores used in analysis were the percentage correct of these three questions. When the videos were used to introduce a new topic, the pre- and post-video quiz were simply the three questions on the topic being shown that day.

For both data sets, a one-tailed paired t-test was chosen to examine any statistical difference between the pre-video quiz and post-video quiz means. The authors were testing the null hypothesis that the mean correct percentage of test scores for the pre-video quiz will be equal to the mean of the post-video quiz (no effect from watching the videos), with the alternate hypothesis that the post-video quiz mean is higher (learning improved after watching the videos). This hypothesis set represents the primary research question of the student-produced video project: to what extent does learning, here embodied as quiz performance, improve after watching student-produced videos? In addition to noting the results of the paired t-tests, the mean pre- and post-video quiz scores were calculated to gauge the relative effectiveness between video topics and to check for negative impacts. Note that a p less than 0.05 from the paired t-tests indicate a statistically significant difference between the means of the pre- and post-video quiz data at the 95% confidence level.

RESULTS AND DISCUSSION

Student Video Production Process and Products

The students selected a variety of formats for their videos, but the most commonly used styles are animated power point presentations, as shown in Video 2, live action (scripted acting [Video 3], speeches [Video 4], or interviews [Video 5]), and a combination of live action and power point slides [Video 6]. Some students shy away from the camera, opting to get friends to do the acting and voice-overs [Video 7] or even to turn their dogs into actors [Video 8] (there have been three dog-actor films to date).



Video 2. Animated Power Point Produced Video Featuring Students' Text-to-talk Feature on Their Smartphones.

Video 3. Video Project Featuring Scripted Acting.

Video 4. Student Giving a Speech with Superimposed Background.

Video 5. ***Interview of a Local Professional.***

The most common edit needed for live action films is to add some on-screen text to draw the viewer's attention to an important point being made. Animated power points often move too quickly and need to be adjusted for more time on a slide or need to add a voice component to be the tour guide to the text. An undergraduate research assistant provided with movie editing software can usually make the needed adjustments to a video.

Video 6. ***Students' Mixed Scripted Acting with Power Point Slides.***

Video 7. Student's Friend Acting in their Video Project.

Pre- and Post-Video Quizzes – Semester Project Videos

Table 1 presents the mean pre- to post-video quiz scores and paired t-test results from four semesters of student projects debuted during this study. The topics listed were the subjects of the various student projects. While there is variation in performance improvement levels, nearly all topics showed an increase in quiz scores pre- to post-video presentations with an average improvement of 15.7%. Not all of these improvements were statistically significant, as shown in Table 1, with the about a quarter (7

Video 8. Student's Dog Starring in their Silent Film Project.

Table 1. Mean pre- and post-video quiz scores, degrees of freedom, t-statistic, significance level by topic when presented as class project. p < .05 highlighted.

Topic	Semester Debuted	Pre-Video Quiz *M*	Post-Video Quiz *M*	*df*	*t*	*p*
Bidding Process	Fall '12	68	79	21	2.31	**.016**
Comparison Cost Estimates	Spr. '15	57	76	30	4.23	**< .001**
Concrete	Fall '12	70	90	20	3.28	**.002**
Construction Bonds	Spr. '15	44	82	30	6.57	**< .001**
Doors & Windows (version 1)	Fall '12	58	64	21	1.45	.081
Doors & Windows (version 2)	Spr. '14	76	94	30	3.54	**< .001**
Drywall	Spr. '14	71	82	30	1.58	.062
Electrical	Spr. '14	83	94	29	2.41	**.011**
Equipment (version 1)	Fall '12	90	92	19	0.29	.386
Equipment (version 2)	Spr. '14	76	80	29	0.94	.177
Intro to Estimating	Spr. '14	72	86	28	3.55	**< .001**
Intro to Estimating/Estimate Types	Spr. '13	82	97	21	4.18	**< .001**
Jobsite & General Overhead	Spr. '13	71	85	21	2.88	**.004**
Labor	Spr. '14	73	74	30	0.21	.420
Masonry	Fall '12	48	86	21	4.57	**< .001**
Materials	Fall '12	40	63	19	3.91	**< .001**
Metals (version 1)	Spr. '13	82	82	19	0.03	.487
Metals (version 2)	Spr. '14	62	74	30	2.25	**.016**
Overhead Costs	Spr. '14	38	78	30	7.14	**< .001**
Plumbing	Spr. '13	80	72	19	1.08	.147
Sitework	Spr. '14	53	60	29	1.80	**.042**
Types of Estimates	Fall '12	53	74	21	3.31	**.002**
Waterproofing	Spr. '14	44	84	30	8.87	**< .001**
Wood	Fall '12	68	88	21	4.16	**< .001**

of 24) of the changes having a *p* greater than 0.05. As the video projects were debuted after similar materials were covered by the course during the semester, it was expected that the class would have some pre-existing knowledge. As such, some of the projects with small or statistically insignificant gains in quiz improvement might be presenting material that the class already knew, or they might have quiz questions that were too easy. This initial presentation of videos and quiz questions was helpful to discover issues with quiz questions or videos that can be corrected before using the videos to introduce lecture topics in subsequent semesters. The topics of particularly poor videos or of videos made by students who declined to grant permission for their projects to be used in the future were often offered anew as an available topic to subsequent semesters.

Pre- and Post-Video Quizzes – Videos as Lecture Topic Introduction

When using prior semesters' projects to introduce lecture topics, the authors had the opportunity to further refine poorly performing quiz questions and to edit some of the student-made videos. Because low or statistically insignificant performance improvement during the debut semester was often attributed to students' pre-existing knowledge, videos were left largely unchanged during the first semester of their use as a lecture topic introduction unless there was a factual error. However, quiz questions were often refined, especially when the results from the video's debut had a negative change from pre- to post-quiz scores. Generally the student-produced videos, polished through this review and edit process, facilitated gains in knowledge as measured by the pre- and post-video quizzes and shown in Table 2. Even with three quizzes in which pre- to post-quiz change was negative, there was an overall mean improvement of 22.3% in correct responses from pre- to post-quiz performance from viewing the student-made videos. A one-tailed paired t-test between pre- and post-video quiz scores typically validated the statistical significance of this trend. These t-tests results, shown in Table 2, indicate with 95% confidence that students' performance had a statistically significant improvement on the post-quiz versus the pre-quiz from watching the video for most (79%) of the topics. As the pre- and post-video quizzes were administered immediately before and after the screening of the video, all gains in performance are attributed to watching the student-produced video: the asynchronous peer-to-peer learning. The one topic with a statistically significant decline in scores, Bidding Process, has a quiz question that has been leading to this decline as the original video very clearly presents only part of the answer. It has since been edited to explicitly address the missing part of the question for hopes of improvement in the future. The Estimating Equipment topic has improved in performance because a new student video is now being used to introduce this topic and Estimating Materials improved through the editing of the quiz questions. The results for the topic of Sitework are presented for only two questions because there was an error with the classroom response system in that it failed to record the post-video responses for the third quiz question. As not all students were present or on time to class, only students who completed both the pre- and post-video quizzes for a topic were included in the analysis. Therefore, the number of students for each semester is listed as a range to represent this variance and the degrees of freedom are listed for each t-test. Topics with dashes for a semester represent videos that were not shown that semester, which is typically because they had not yet been created.

Survey of Student Perceptions Results

In the first two semesters of this study, only graduate students in this dual-listed course were assigned the video project. After the graduate students' video projects were screened, the

Table 2. Mean pre- and post-video quiz scores, degrees of freedom, t-statistic, and statistical significance for student-produced video used to introduce a new topic in class. p < .05 highlighted.

	Spring 2013 (n=21-24)					Spring 2014 (n=22-30)					Spring 2015 (n=21-31)				
Topic	Pre *M*	Post *M*	*df*	*t*	*p*	Pre *M*	Post *M*	*df*	*t*	*p*	Pre *M*	Post *M*	*df*	*t*	*p*
Bidding Process	60	88	23	6.41	**< .001**	85	77	27	1.80	.041	86	74	28	2.37	0.013
Bonds, Ins., & Contingencies	-	-	-	-	-	80	98	26	3.85	**< .001**	50	94	25	7.54	**< .001**
Concrete	60	83	23	4.62	**< .001**	59	87	24	4.45	**< .001**	80	96	22	3.14	**.002**
Doors & Windows	49	51	22	0.30	.385	67	94	22	5.09	**< .001**	-	-	-	-	-
Equipment	76	82	23	1.00	.164	88	93	26	1.16	.128	64*	94*	29	5.83	**< .001**
Jobsite & General Overhead	-	-	-	-	-	49	69	26	4.12	**< .001**	46	70	26	3.91	**< .001**
Labor	-	-	-	-	-	-	-	-	-	-	70	86	26	3.57	**< .001**
Masonry	49	98	21	6.02	**< .001**	63	100	25	5.97	**< .001**	53	96	24	8.68	**< .001**
Materials	69	79	23	1.37	.092	81	79	27	0.46	.323	69	82	30	2.44	**.010**
Metals (version 2)	-	-	-	-	-	-	-	-	-	-	62	92	27	6.89	**< .001**
Plumbing	-	-	-	-	-	72	97	23	4.1	**< .001**	72	99	29	7.18	**< .001**
Sitework**	-	-	-	-	-	-	-	-	-	-	84	100	24	2.87	**.004**
Thermal Protection	-	-	-	-	-	-	-	-	-	-	29	100	23	14.05	**< .001**
Types of Estimates	68	92	23	3.82	**< .001**	57	90	29	5.39	**< .001**	71	95	20	5.84	**< .001**
Wood	62	86	21	4.45	**< .001**	72	89	21	2.57	**.009**	65	91	25	5.13	**< .001**

*Notes: * Indicates a new video on this topic was used. ** Indicates that two questions were used for analysis of this topic.*

undergraduate students were surveyed on a five-point Likert scale to see how informative they perceived these videos to be. The results of this survey are shown in Table 3.

All students were assigned to contribute to a video project during the third and fourth semester of the study, although the requirements were more extensive for the graduate students than for the undergraduate students. At the end of these semesters the class was surveyed about their enjoyment of the video project, and these results are shown in Table 4.

Table 3. Survey results to "The graduate students' video projects were informative" (n= 61) from the first two semesters: Fall 2012 and Spring 2013

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0%	0%	8%	62%	30%

Table 4. Survey results to "I enjoyed the video project" (n = 53) from the third and fourth semesters: Spring 2014 and Spring 2015

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0%	6%	17%	38%	39%

From these survey questions, it appears that the students have largely found the video projects to be informational (92%) and a majority of the students have enjoyed the video project (77%). No students disagreed to the survey statement about whether the graduate students' projects were informative and only 5 of 61 students surveyed were neutral on the questions. There are some students who did not enjoy the video project, but they are in the minority (3 out of 53). These results reflect the discussion in this classroom where most of the students seemed to be interested in creating their video projects, some appeared to be apprehensive about how to do it, and the presentation days are generally very relaxed, with the students cheering for each other.

LESSONS LEARNED AND PRACTICAL APPLICATIONS

A few of the lessons learned and practical applications that the authors would like to share with others considering the use of student projects to generate video content for their course:

- Negative changes from pre- to post-quiz performance are a red flag indicating the need to edit the topic's quiz and/or video. Some of the deficiencies in a video or quiz questions are not evident in the semester that a project is submitted because the students taking the quizzes and watching the videos have just completed the course in and thus have prior knowledge on the topics presented. As well, there are some semesters where some videos do not perform as well as others
- Following the screening of a video used as an introduction of a new topic, students would often comment on confusing points in a particular video. Embrace this verbal feedback when editing the video or quiz for future semesters, as there is no need to guess about what was confusing, because the class just served as a de facto focus group to comment upon that particular video.
- Do not worry about defining lots of details in a video project assignment. Most students do a good job of being factual and creative. Some just-in-time style assistance is useful, such as providing some general audio/visual guidelines. The students needed some guidance to

steer them away from having the audience read power point slides or from giving all auditory information without visual reinforcement.

- Students are not necessarily great at writing multiple-choice questions. The questions that they generated could often be too easy or confusing. To try and assist the students with their questions, the project prompts do require these questions to be submitted a week before the video presentations so the instructor can review them, make corrections, and email for clarifications. The instructor could also give a quick tutorial on making a great multiple-choice question (either in class or on the course website).
- Some students will do a better job than others. As such, do not expect to have the ideal set of videos for your course at the end of a single semester. Plan on having a student research assistant do some video editing to polish the videos with small flaws to improve the videos for future use. Some videos would take so much work to polish that their topics should just go on the next semester's project list.
- Make your classes work for you. For instance, the authors are using this project to develop future course content.

LIMITATIONS

This study has been conducted in only one class with the same instructor for this implementation. Construction Estimating was selected for the implementation of this study because one of the authors is the instructor for it and desired to flip the course. Additionally, there was no comparison group exploring whether similar pre- to post-quiz score improvements could have been achieved through a reading assignment or listening to a brief amount of lecturing from the instructor. There is also no existing concept inventory for this subject matter that would have allowed a more robust comparison of learning gains using these student-produced videos or any other method of instruction. As such, the relative effectiveness versus these other content delivery methods is not explored in this paper. The student satisfaction surveys were intended as a check to see if the consumers of the new video content (the students in the course) felt that watching or creating the videos was a worthwhile use of their time, which might link to student engagement. These measures of satisfaction were the students' opinions, and are not tied to a particular learning outcome for the course. As a result of these limitations, the findings presented in this paper provide support for the hypothesis, but cannot completely confirm that asynchronous peer-to-peer is effective.

Thus far, no students registered with Disability Services in this course had a visual or hearing impairment. Whenever such an occasion arises, the instructor will work with the university's Office of Disability Services to provide accommodation (closed captioning, e.g.), as appropriate. The students appearing in the full collection of videos are predominately White and Hispanic males, which is representational of the student demographics enrolling in this course. At the time of this study, the students required to take this course within the Department of Engineering Technology were 6.4% female and 93.6% male. By self-identified race and ethnicity, the student population under investigation was 0.3% American Indian or Alaskan Native, 0.9% Asian, 3.4% Black or African American, 22.0% Hispanic, 0.6% International, 1.5% Multi-racial, 69.5% White, and 1.8% Unknown. This student demographic information for the program is provided for context, but the data was not examined for any effects based upon student gender, race, or ethnicity. Of the eight videos presented in this paper, three were created by Hispanic students, although they did not all choose to be recorded on film. Owing to the existing student population, this project does risk the possibility of perpetuating gender and ethnic stereotypes, but the researchers have hoped that the student engagement that might result from peer instruction would outweigh any negative effects. For instance, students have anecdotally reported that supervisors for their internships have been past students appearing in these videos and that the current students were thus able to use the videos to break the ice in conversation and form a better connection to their internship company.

CONCLUSIONS AND FUTURE WORK

This study presents a unique perspective on the use of student-produced video to create course content in a Construction Engineering course. During this study period the content was used in class to introduce new topics, but is expected that this content could be used to support flipped instruction. Based upon the typically statistically significant improvement in student quiz scores from watching the student-produced videos, this study provides support for the hypothesis that these student projects can enable asynchronous peer-to-peer learning. This evidence of increased student learning is in line with similar studies that used pre- and post-test measures to evaluate the effectiveness of flipped instruction models (Karabulut-Ilgu & Jahren, 2016; Mason, Shuman, & Cook, 2013). Further, when surveyed about their enjoyment or the informational value of the projects, the students indicated that they viewed the projects favorably (only 6% disliked it) and overwhelmingly indicated the projects were informative (no students disagreed). The impact of these videos goes beyond the student perceptions and learning impacts by also creating course content for the instructor to be used in future courses. This evidence of student engagement is in line with many studies that found positive student perceptions of the flipped instruction model (Mavromihales & Holmes, 2016; Strayer, 2012; Zhao & Ho, 2014).

This paper presents an ongoing study, and the authors hope the results from the first four semesters is useful and inspiring for other instructors interested in generating student-produced video content for their courses. Based upon the positive results on student learning revealed during this phase of the study, the authors plan to use the university's course management software to create online modules featuring these videos and quizzes for students to complete prior to class in order to flip the course in future semesters.

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APPENDIX

The project statement (Figures 1 and 2) and grading rubric (Figure 3) from one semester (Spring 2015) of this project are provided for the reader's reference.

CSM 4361: Construction Estimating
Term Group Project

Description

The term project is to make a short (2-3 minute range) videos that introduce key estimating concepts. To accompany each video and to gauge the effectiveness of the presentation, the project will also require a pre- and post- video quiz to be developed and administered by each group. The videos will be presented in class on the due dates indicated. This project embodies the concept of peer-to-peer learning as well as demonstrating your knowledge of the material. The topic of your team's video shall be related to the topics scheduled in the syllabus. Your group can produce an overview video on a topic (similar in depth and breadth as the ones being shown in class), or an in-depth look at a specific estimating concept. Your group will claim your topic and declare your group members via the forum on TRACS and topics are first come, first served.

You will work on a group of three or four students. If you are having trouble finding a group, talk with Dr. Talley. Any students who help a graduate student in addition to their own project (and makes the credits of the graduate student's video) will receive extra credit on their homework average.

Action Items

1. *Claim your topic and team on TRACS by March 9th, 2015.* I have set up a Forum titled "Claim Project Topics and Teams Here!" Post a new thread to the discussion with your team members (don't forget your own name) and your topic. If another group has already posted the topic you were going to pick, you will have to choose a different one (no repeats). One post for the whole team is sufficient.
    a. Claim should state topic name and whether "overview" or "in depth" type
    b. Group members. Groups must have three or four members.
    c. Topic must be approved by Dr. Talley
2. Do a little digging (there should be more information than in the textbook or lecture). Find out some detailed information about your chosen topic. Items include, but **are not limited to**:
    a. What is it? (Full name & common name or abbreviation)
    b. Why do we use it? (Why should your classmates care about this topic?)
    c. What makes this topic unique? (It is especially handy for….)
    d. Who uses it?
    e. When during the design, bidding, or construction phase would you use this topic?
    f. Something interesting about this topic that you learned while completing this assignment.
3. Make a video about your topic to show to the class. The video should be 2-3 minutes long. If you want to make a longer video, you will need to negotiate with Dr. Talley in advance for extra time.
4. Develop a comprehension quiz (three questions, multiple choice format) to accompany your video. You must **submit your questions via DropBox to Dr. Talley one week prior to the due date** of the project. The quizzes for all of the topics will be administered together as a pre- and post- quiz at the start of class and then after all of the videos are shown to gauge student learning on your topics. Improvement in student learning/understanding of your chosen topic will be a portion of your grade.
5. Play your video for the class on the due date. You are responsible for making the video play on the podium system in class. HIGHLY RECOMMENDED to check your sound in advance.
6. Submit an electronic version of your video to Dr. Talley (via DropBox) by ALL group members as either an MP4 or an AVI file format.

Due Dates

Claim Topic & Team due by Monday, March 9th.
Quiz questions are due Monday, April 27th.
Present video in class on Monday, May 4th.
Submit video via Drop Box on TRACS (by ALL group members) by presentation time.

Page 1 of 2

Figure 1. Project Statement from Spring 2015, Page 1.

Topic Ideas (not an exhaustive list)

1. Project Comparison Estimates
2. Types of Bids
3. Labor/Equipment/Crew Productivity
4. Labor Burden
5. Davis-Bacon Act
6. Equipment Operating/Ownership/Rental Costs
7. Bonds
8. Stripping Topsoil
9. Bank, Compacted, and Loose Cubic Yards of Soil
10. Estimating Fill/Backfill (called General Excavation in textbook)
11. Estimating Rebar
12. Estimating Masonry
13. QTO – Metals
14. QTO – Wood
15. Estimating Moisture Protection
16. Estimating Finishes (an overview OR any in depth topic except for drywall)
17. Estimating Mechanical Work
18. Estimating Electrical Work

Figure 2. Project Statement from Spring 2015, Page 2.

CSM 4361: Construction Estimating
Spring 2015

Evaluation Rubric
Video Group Project

Students' Names______________________________ Overall Grade______

Areas of Evaluation	Needs Improve-ment	Fair	Good	Great!	Comments
Video Content (Technical Content) **45%**					
Video (Sound/ Image) **10%**					
Quiz Questions **10%**					
Student Learning (Pre/Post Improvement) **15%**					
Innovation/ Originality/ Creativity **15%**					
On-time Topic Claim **(5%)**					

Figure 3. Evaluation Rubric for Video Project.