ASEE's 123rd Annual • Conference & Exposition • New Orleans, LA • June 26-29, 2016

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Paper ID #16325

Pre- and Post-Class Student Viewing Behaviors for Recorded Videos in an Inverted Sophomore Mechanics Course

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Abstract

The inverted classroom has gained significant traction in higher education over the past several years. While inversion can take on many specific forms, it usually implies some shift of theoretical lecture content away from the in-class time and into the student time spent outside the classroom. Students are expected to watch recorded video lectures before coming to class and then the time in the classroom is spent with students working on problems in some form. This active learning strategy allows the focus of faculty-student interactions in class to be on the application and higher levels of Bloom's taxonomy that are usually targeted in engineering and similar technical courses.

While these pre-recorded lecture videos are an essential component of an inverted course structure, little data has been made available on how students actually watch these recorded videos. This paper presents the results of a study of student viewing behaviors for pre-recorded video content in an inverted introductory sophomore mechanics course. Data is presented for both theory-based lectures intended to be viewed prior to class, and for recorded example problem solution videos that review problems solved during class meetings.

Data from the video distribution system was used to answer a series of research questions related to student viewing behaviors. The observations presented in this paper indicate that on average, students watched a little more than half of the recorded lecture content that they were expected to. Viewing rates steadily decreased throughout the semester, but were not affected by video length or day of week. Female students were found to exhibit significantly higher viewing rates than their male counterparts. Effectively, no correlation was observed between viewership rates and course performance as measured by final course grades.

Introduction/Course Structure

In the College of Engineering at Villanova University, several courses have been transitioned to an inverted format over the past four years. In the Department of Civil and Environmental Engineering alone, the entire five course sequence in mechanics and structures is now offered in this format as indicated in Table 1. In all five of these courses, students are required to watch theory-based lecture videos that are designed with the primary intent of preparing students for solving problems in class. While the format and delivery of the lecture videos is similar, the strategies for encouraging, ensuring, and rewarding students for watching videos vary among the individual courses. Some courses give credit for viewing videos, and some courses use short quizzes based on the lecture video content. The course that is the subject of the study in this paper, Mechanics I, does not give any credit toward the final course grade for watching videos, nor does it rely on quizzes related to the video content.

Table 1 – Mechanics and structures sequence in CEE at Villanova University

Course	Credit Hours	Semester	First Inverted Offering
Mechanics I	4	Sophomore Fall	Fall 2013
Mechanics II	4	Sophomore Spring	Spring 2015
Structural Analysis	3	Junior Fall	Fall 2015
Structural Steel Design	3	Junior Spring	Spring 2014 #
Reinforced Concrete Design	3	Senior Fall	Fall 2014 #
# Prior to 2014, Structural Steel Design and Reinforced Concrete Design were offered in a single combined course. This course, Structural Design, was first offered in the inverted format in Spring 2012.			

Mechanics I is an introductory mechanics course that covers traditional concepts of Statics and Mechanics of Solids with emphasis on axial loading. Basic material properties such as strength and stiffness of linear elastic materials such as steel are also addressed. Mechanics I is offered every fall semester and is typically taken by first-semester sophomore students. The four-credit course meets three times per week for 50 minutes (on Monday, Wednesday, and Friday) and once per week for a 165-minute flex period (on Thursday). The course is co-taught by a pair of faculty members (the authors of this paper) and is always scheduled with two sections of 20 to 30 students each. The same instructors co-teach both sections and the second section always meets immediately after the first section, so the two sections are effectively considered identical. The first section meets at 8:30 AM on Monday, Wednesday, and Friday and at 11:30 AM on Thursday. The second section meets at 9:30 AM and 2:30 PM on these days respectively.

Mechanics I was first offered in Fall 2009 and was first presented in an inverted format in Fall 2013. The content did not change when the inverted format was implemented, but the course structure did. Prior to all but five class meetings, a link to a theory-based video lecture recording is posted on the online course management system (Blackboard). Students are expected to watch the video prior to attending class. During each class meeting, the instructor leads students in a real-time manner through two or three example problems. Students transcribe the solutions to the problems, and the instructor uses these problems to reinforce important theoretical concepts from the video lectures. The instructors believe that the real-time nature of the problem solving (as opposed to simply providing a pre-solved problem with a solution worked out ahead of time) and the extra time permitted by shifting the theory to a pre-class video lecture, allow for better learning at the application level in the classroom. In many cases, particularly in the second or third example problem for a particular class meeting, students are asked to solve parts of the problems independently and then compare their answers to the instructor solution. If any time remains after the example problems are worked through, students are asked to start their assigned homework problems and encouraged to ask the instructor for assistance as needed.

Students are not required to purchase a textbook for the course, and instead students purchase a pre-printed course binder that includes all lecture notes associated with the videos, and all example and homework problems that will be solved during the semester. The decision to not require a textbook was made based on student feedback from the first few years of the course (prior to inversion). Since all of the problems solved in class and assigned for homework were created by the instructors, students felt that they used the text very little and that it was not essential to have a textbook to be successful in the course. Student feedback from the inverted version of the course confirms that students still do not feel that a required textbook is warranted.

For the first three years of the inverted version of this course (including 2015, from which the data for this paper is based), the instructors decided not to award students any formal credit toward the course grade for watching the lecture videos before class. Furthermore, quizzes based on the lecture theory have not been implemented. Instead, the instructors continually reiterate the importance of the lectures in preparing students for learning during class meetings and state the expectation that students are watching the lectures. The instructors elected not to provide any formal credit for watching lectures in large part to stay consistent with the historical approach of having student assessment in the course focused on application (i.e. solving problems correctly).

Video recordings are also used to provide an opportunity for students to enhance their learning after class meetings. The theory-based lecture videos that students are expected to watch before class are available after class for students who wish to review this content further. Additionally, the instructors have recorded video solutions to all example problems solved in class. These problem solution videos are made available immediately after each class period so that students can review them for clarification while working through similar homework problems or studying for exams.

Literature Review

There has been a pedagogical shift in the past twenty years towards *problem based learning*, the incorporation of *concept oriented examples*, and the use of *interactive learning activities* within undergraduate engineering, science, and medical school curricula[1-4]. Assessments have demonstrated that students generally learn better when taught in these environments[5-8]. Problem based learning has been widely implemented within individual courses, while some departments and colleges have incorporated the philosophy systemically throughout entire programs.[9-11] Development of pre-recorded material is one method to free up in-class time to support more active learning experiences.

Pre-recorded lecture material to support student learning is not a new idea. In 1985, Pytel reported on an early implementation of lecture videotapes for statics. The theory was presented in a series of eleven one-hour videotapes. Students were given equivalent release time from class to view the lecture videotapes, at their convenience.[12] In 1999 the University of Oklahoma relied on laptop computers, CD-ROMs, and the intranet for teaching their statics class. The wireless connections allowed all lectures to be broadcast over the internet and minimized the need for the student to attend the actual class.[13] These early efforts were aimed at moving traditional lecture outside of the classroom; however, they did not focus on replacing the in class time with active learning modules.

To facilitate active learning within the classroom, the flipped or inverted structure has been utilized in introductory mechanics courses. At Western Michigan University, a redesigned statics course combined traditional classroom lectures and flipped classroom activities. Over 60 online videos were created so students could watch and learn at home.[14] Similarly at the University of Wisconsin, an inverted model was used for both statics and dynamics. Recorded videos of lectures, as well as videos of solved problems, were placed online for students to view prior to attending class. Class time was then devoted to a combination of instructor-guided problem solving as well as student-led problem solving.[15]

As more universities move towards an inverted format for mechanics courses, it is important to assess the factors that impact learning. Studies that compare the traditional and flipped formats have shown the benefits of the flipped classroom. A study at the University of Colorado, Boulder showed no clear link between instructional methods and student understanding of statics concepts but did show a student preference for the more active, student-centered classrooms.[16] North Carolina State University and Florida Institute of Technology partnered to test the hypothesis that familiarity with the presenter in the video is optimal for student learning. To determine if there were differences in performance between students who viewed course videos by the local professor and students who viewed the non-local professor, scores on various assessment tools were analyzed using the ANOVA procedure. This study did not find a significant difference in academic performance between students who viewed videos featuring their classroom professor and students who were instead exposed to a non-local professor. Additionally, an end of course survey revealed that in general students had no preference for who was featured in the videos.[17]

It is clear that the pre-recorded material is an essential component of an inverted mechanics course, yet there is no data available on the viewing habits of students. To better implement this teaching pedagogy, it is imperative to understand how students view the recorded content and establish how that behavior relates to student learning.

Objectives

In the first two offerings of the inverted Mechanics I course at Villanova University (2013 and 2014), detailed data on whether students watched videos and how they watched them was not readily available. Instructors could have obtained information on “clicks” via the course management system, but this would only indicate whether a student clicked on the link to access a video, and would provide no information on whether they watched the entire video, whether they rewatched individual parts of the video, etc. Furthermore, accumulating this limited data would have been an extremely laborious task because of how the data was stored in the course management system. The instructors did solicit feedback from students using a survey at the end of semester, but these responses of students self-reporting on a summary basis do not allow for the questions posed below to be answered in any significant level of detail.

In the summer of 2015, the College of Engineering moved all video content to an upgraded Mediasite video catalog system that allows for much more extensive data collection related to how videos are viewed by students. This paper presents observations from a comprehensive analysis of that viewing data for the Fall 2015 offering of Mechanics I. The following research questions are addressed:

1. How often do students actually watch the theory-based lecture videos before class, and do they watch the entire videos or only a portion?
2. Are before class viewership trends for theory-based lecture videos affected by duration of the video, day of the week, or stage (e.g. beginning, middle, end) of the semester?
3. How often do students watch (or rewatch) portions of the theory-based lecture videos after class?
4. Do students rewind and rewatch portions of the lecture videos frequently?
5. How often do students watch the example problem solution videos after class?
6. Do statistical correlations exist between student pre-course GPA and viewership data?
7. Are there differences in viewership trends between male and female students?
8. Do statistical correlations exist between course performance (numerical course grade) and before class viewership trends for theory-based lecture videos, or between course performance and viewership trends for example problem solution videos?

End of Semester Student Survey Results

Before discussing the detailed viewing data, it is useful to report the results from the student survey given at the end of the course. Results from this survey are summarized in Table 2. These surveys were administered by handing out the survey during the last week of class and requiring students to submit it before the final exam, ensuring a near 100% return rate. The surveys were anonymous and included several multiple choice rating questions and an opportunity for open student comments at the end of the survey on anything related to the inverted format of the course. Although the survey covered many topics, only data on selected questions related to video recordings is presented here. Surveys used a simple 1 to 5 scale for responses, as indicated in the table.

The survey responses imply that students watched the required lecture videos before class more often than not, but at far less than a 100% completion rate. The responses also indicate that while students agree that the recorded lecture videos have inherent value and provide a strong background, students only marginally feel that watching the videos is necessary to succeed in the course. On the other hand, results suggest that students feel the problem solution recordings are very useful for reviewing application of concepts after class.

Table 2 – Student responses for end of semester survey questions

	Fall 2013	Fall 2014	Fall 2015	Three Year Composite
# Student Survey Responses	n = 48	n = 56	n = 46	n = 150
I watched the lecture videos.	3.83 (1.04)	3.05 (1.27)	3.80 (1.24)	3.53 (1.24)
I learned a lot from the lecture videos.	3.50 (0.80)	3.14 (1.23)	3.72 (0.98)	3.43 (1.05)
The lecture content provides a strong background for solving the problems in the problem sets.	4.00 (0.68)	3.66 (0.92)	4.00 (0.92)	3.87 (0.86)
I have gone back to rewatch lectures or segments of lectures when I needed further understanding on a topic.	3.48 (1.46)	3.82 (1.08)	3.65 (1.37)	3.66 (1.30)
I believe that it is necessary to watch the video lectures to succeed in this course.	3.25 (1.04)	2.75 (1.24)	3.46 (1.38)	3.13 (1.25)
I found the recordings of problems solved in class to be helpful (for clarification, studying, etc.)	4.23 (0.83)	4.34 (0.90)	4.24 (0.92)	4.27 (0.88)
Values are mean responses with standard deviations shown in parenthesis on a 1 to 5 scale: [1 = Strongly disagree; 2 = Mildly disagree; 3 = Neutral; 4 = Mildly agree; 5 = Strongly agree]				

Table 3 – Summary statistics on video recordings for Mechanics I

Video Type	Theory-Based Lectures		Example Problem Solutions	Semester Review
Is video available before class? ("Yes" implies students are expected to watch prior to class)	Yes	No	No	No
# of videos	49	6	92	1
Mean video length (min:sec)	14:19	21:01	13:18	13:00
Median video length (min:sec)	12:51	15:48	11:44	13:00
Minimum video length (min:sec)	3:39	8:27	3:32	13:00
Maximum video length (min:sec)	29:38	51:25	68:03	13:00
Total length of all videos (hr:min:sec)	11:41:07	2:06:06	20:23:59	0:13:00

Data Analysis Methodology

Students have more than 34 hours of recorded material available to them in Mechanics I. There are a total of 49 theory-based lecture videos that students are expected to watch prior to class and an additional six lecture videos that are recordings of theory-based material presented in the classroom and only available after class for review purposes. There are also 92 example problem solution videos and a short review of the semester that is posted prior to the final exam. All videos were recorded by one of the two instructors who co-teach the course, and no videos from outside sources were used. Summary statistics for these different types of video recordings are given in Table 3. Only viewing data for the theory-based lecture videos that students are expected to watch prior to class and the example problem solution videos are discussed in this paper, but this accounts for more than 93 percent of the recorded material.

Although extensive viewing statistics are available, a tremendous amount of data analysis and manipulation is required to make sense of it and answer the research questions posed above. Raw data from Mediasite was downloaded in the form of two CSV data files for each video. The data was then assembled into an Excel file that was programmed to sort the data into a usable form. A total of 2886 individual lecture views reflecting over 428 hours of student viewing time had to be categorized by student and by video title. For theory-based lecture videos, the data had to be further separated into before class and after class views. After the initial sorting of all data, further statistical analysis was performed to establish correlations with factors such as course performance, pre-course GPA, and gender.

Four key terms used throughout this study are defined below:

- Participation – A student is defined to have participated by clicking a video link and watching any part of that video recording.
- Coverage – Coverage is defined as the percentage of a given video or set of videos that is watched by a student. Coverage considers what portions of a video were actually watched, and is not simply computed as the total time viewed divided by the video length. Repeat time (defined below) does not increase coverage since it is the same content that is being watched multiple times.
- Full Viewing – A viewing is considered to be a full viewing if the coverage meets a certain threshold level. For this study, the threshold level was defined as 95%. Thus, if a student viewed 95% or more of an individual video (via the coverage metric), it is considered as a full video viewing.
- Repeat Time – Repeat time is time a student spends watching a portion of a video a second, third, etc. time during a single video viewing. Repeat time does not cover new content (and thus does not increase the coverage metric) but increases total viewing time.

Only students who were enrolled for the entire semester are considered in the analysis so as not to skew the results. A total of 51 students were enrolled in the course at the beginning of the semester. Of those, four students elected to withdraw from the course on an authorized basis at various points during the semester. These students withdrew because of either poor performance or a desire to change majors. One other student failed the course due to an unauthorized withdrawal after only attending a handful of class sessions. A total of 46 students were actively enrolled in the course for the entire semester and are considered in the study.

Viewership of Theory-Based Lecture Videos

As noted previously, students were expected to watch these theory-based lecture videos in full prior to most class meetings. Thus, the theoretical goals for these videos would be to achieve 100% Participation Before Class, 100% Coverage Before Class, and 100% Full Viewing Before Class. Statistical information is shown for each metric in Table 4, with data shown for only Before Class viewings as well as Overall viewings (counting before or after class). As might be expected with no portion of the course grade being allocated toward it, viewership falls well below the 100% goal. Results are fairly consistent with the implied viewership based on the end of semester survey. The mean student Before Class Participation was 59%, meaning that students watched some portion of the video before class about three-fifths of the time. In about five out of every six of those views, the student viewed the full (at least 95% of the full) video, meaning that for any given video half of the students watched the full video prior to class. The mean Before Class Coverage ratio was 56% for the entire course. All metrics increase slightly, by about 5%, when Overall viewings are considered. This implies that a few students watched the videos for the first time after class rather than before class.

Data on before class viewing is presented graphically in Figure 1, in which each statistic is plotted versus student percentile. A low percentile value indicates that only a small number of students watched videos at a certain rate, while a high percentile value indicates that a large number of students watched videos at that rate. For example, Figure 1 shows that half of the students watched at least 53% of the video recordings in their entirety prior to class and only 13% of the students watched at least some portion of 90% of the video recordings prior to class. It is interesting that these plots indicate a fairly evenly distributed pattern of viewership, in which there are a similar number of what might be called "frequent" viewers (left portion of the plot), "moderate" viewers (center of the plot), and "infrequent" viewers (right side of the plot).

Table 4 – Summary viewership statistics for theory-based lecture videos

	Mean Student	Median Student	Minimum Student	Maximum Student
Before Class Viewings				
Participation (per video basis)	59%	62%	6%	100%
Coverage (total time basis)	56%	57%	4%	99%
Full Views (per video basis)	50%	53%	2%	98%
Overall Viewings				
Participation (per video basis)	65%	71%	8%	100%
Coverage (total time basis)	61%	62%	6%	100%
Full Views (per video basis)	54%	60%	4%	100%

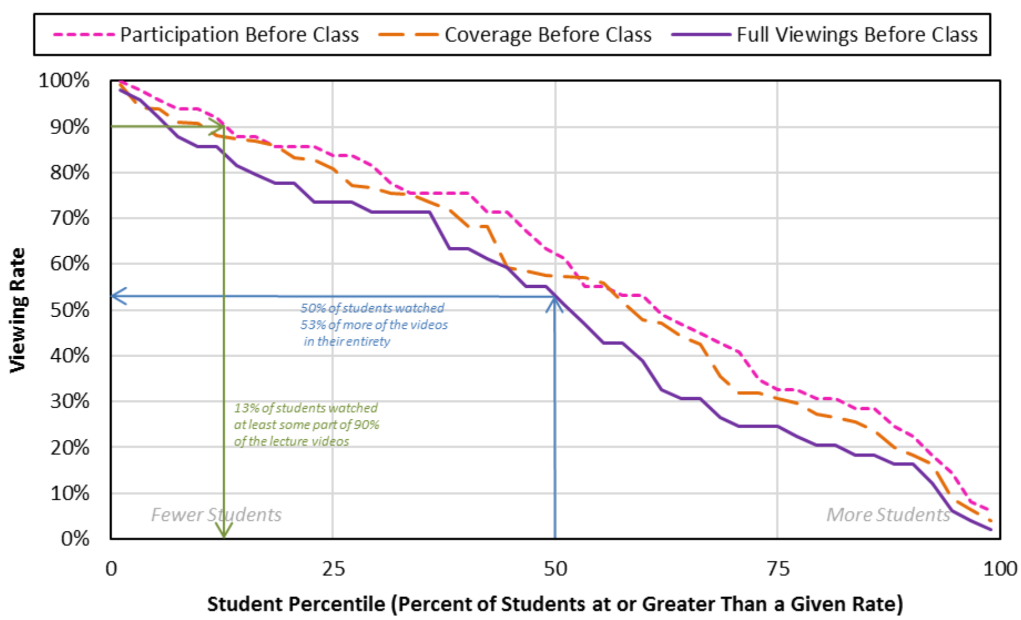

Figure 1 – Before Class student viewership distribution for theory-based lecture videos

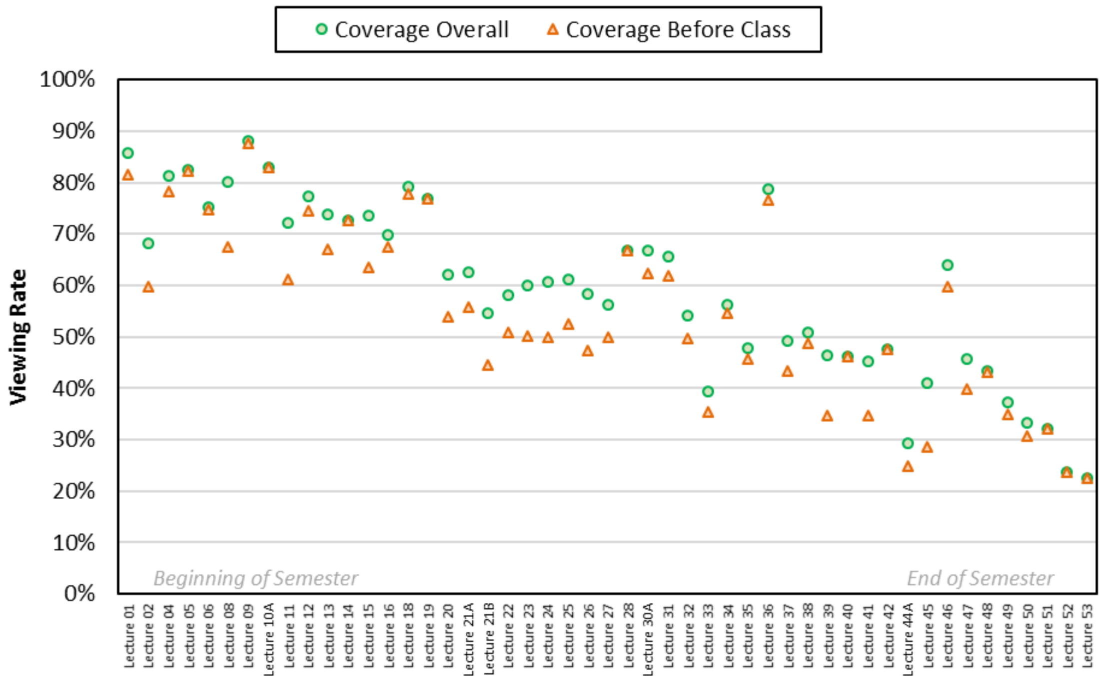

Figure 2 – Coverage trends through semester duration for theory-based lecture videos

Semester-long average statistics provide one look at the data, but additional trends begin to emerge when the viewership data is plotted for all videos chronologically throughout the semester. Figure 2 presents Coverage data for all lectures throughout the semester. Note that there was no video associated with five lectures (Lectures 3, 7, 17, 29, and 43). Participation and Full Viewing data is not shown but follows nearly identical trends as the Coverage data. Average Coverage for a given lecture decreased significantly throughout the duration of the semester, with high Before Class Coverage rates in the vicinity of 75% in the first third of the semester replaced by rates of about 60% and 40% in the middle and final thirds, respectively.

While reasons for this clear trend cannot be proved using the available data, it is the opinion of the authors that this reflects three factors. First, students have made their own individual evaluation of the value and importance of the lecture videos after watching the first several videos. Attempts by faculty to convince students to watch videos later in the semester are therefore less persuasive. Second, students' own perception of their work load tends to increase in the later parts of the semester and they feel that they have less time available, particularly after fall break (which falls between Lectures 26 and 27). Third, the period of the course between Lectures 31 and 39 focuses on content such as centroids and equivalent force patterns, which based on historical performance, tend to be topics that students grasp fairly easily. Students may be able to succeed without much reliance on the lecture videos for this part of the course, and combined with the other factors previously mentioned this may discourage students from spending time on before class theory-based lecture videos in the final part of the semester.

Other interesting comparisons can be made by comparing viewership data to video duration and the day of the week on which a class day falls. As can be seen in Figure 3, there is virtually no correlation between Before Class Coverage and duration of video. Analysis based on day of the week also shows no significant trends. Whereas Before Class Coverage for the entire semester was 56% overall, the rates for Monday, Wednesday, Thursday, and Friday class days were 57%, 58%, 60%, and 50%, respectively. While there is a small decrease in viewership for Fridays, it is not very significant.

All of the lecture videos that students were expected to watch before class were also made available after class. After Class Participation is compared to Overall and Before Class Participation in Figure 4. Note that these statistics are not additive; if an individual student participates before class and then again after class, she is only counted in the overall participation rate once. The mean After Class Participation Rate for the entire semester was only 13%, as compared to Before Class and Overall rates of 59% and 65%, respectively. Like Before Class Participation, After Class Participation can be seen to drop gradually through the duration of the semester. As can be seen in Figure 5, much of the After Class Participation was concentrated among selected students. Only about 10% of students watched more than a quarter of the video lectures after class, and more than half of the students watched less than 10% of the lecture videos after class.

Figure 6 shows trends related to repeat viewing, associated with students rewinding a video to rewatch a portion of the video one or more times during the same lecture viewing. The Overall Repeat Viewing rate for theory-based lecture videos for the entire semester was only 2%, meaning that on average students only rewatched 2% of any given video. The highest individual student Overall Repeat Viewing rate was 19% but only a handful of students had Repeat Viewing rates exceeding 5%. It is clear that most students viewed most lecture videos with little to no rewinding during playback.

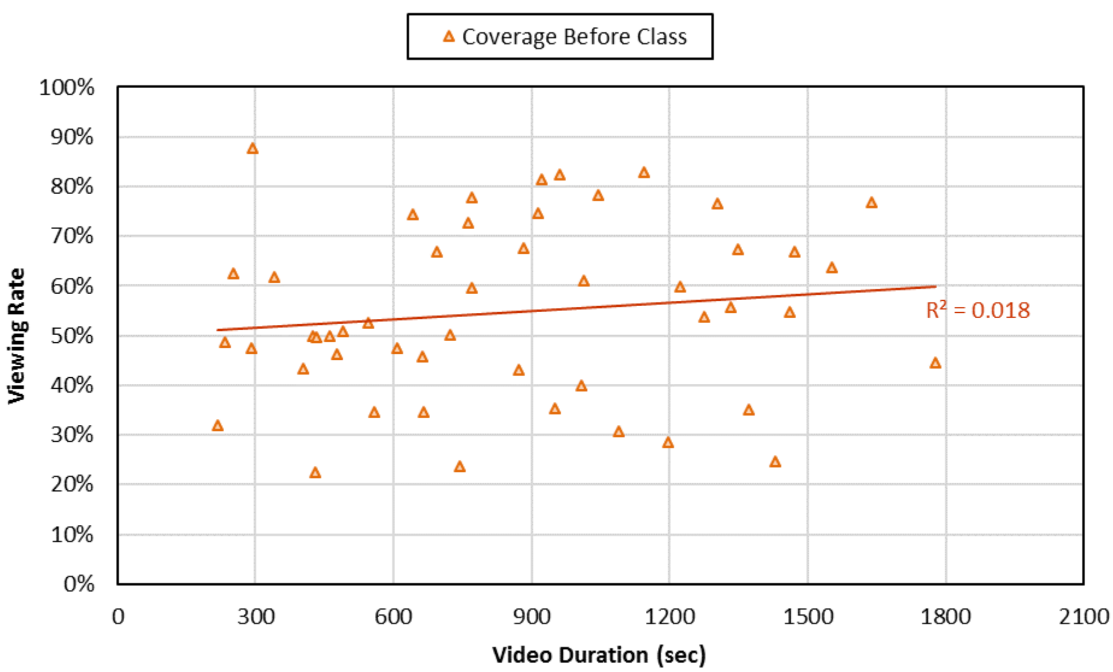

Figure 3 – Coverage trends through semester duration for theory-based lecture videos

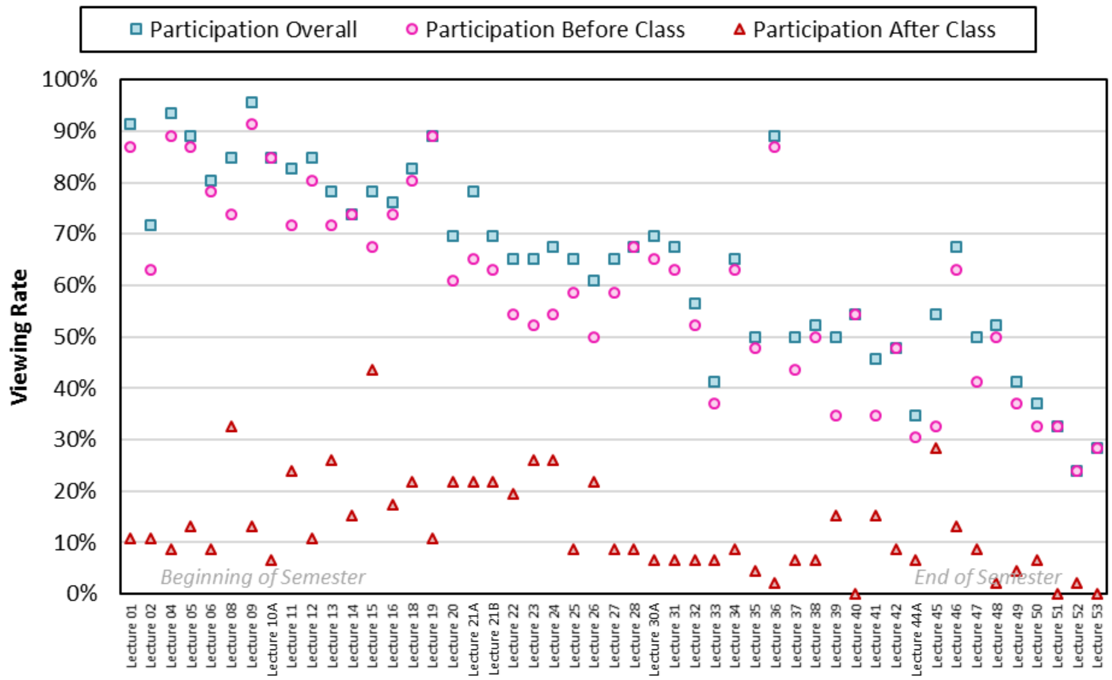

Figure 4 – Participation trends through semester duration for theory-based lecture videos

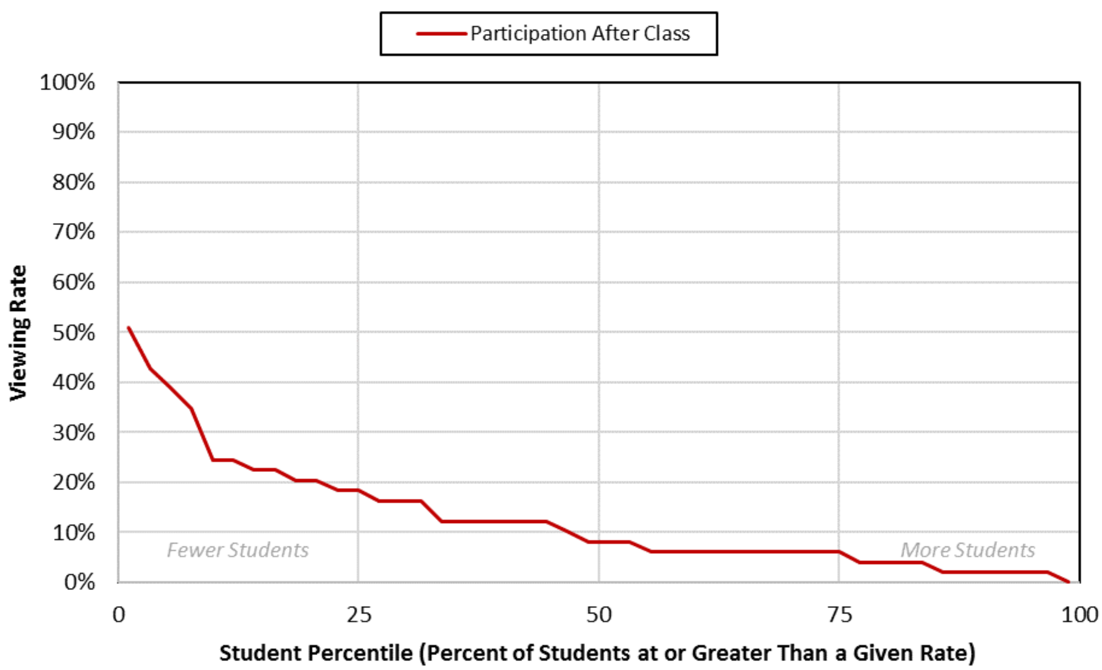

Figure 5 – After Class Participation student viewing distribution for theory-based lecture videos

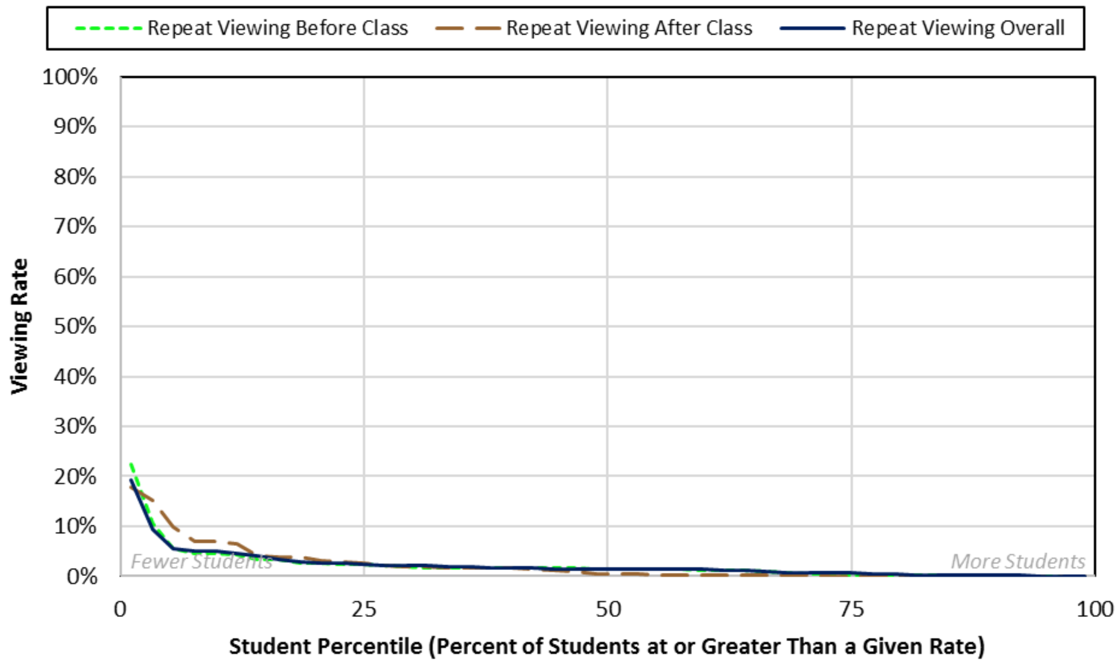

Figure 6 – Repeat viewing student viewership distribution for theory-based lecture videos

Table 5 – Summary viewership statistics for example problem solution videos

	Mean Student	Median Student	Minimum Student	Maximum Student
After Class Viewings				
Participation (per video basis)	15%	10%	0%	92%
Coverage (total time basis)	6%	4%	0%	37%
Full Views (per video basis)	3%	2%	0%	14%

Viewership of Example Problem Solution Videos

As noted previously, example problem solution videos are posted for students to view on demand after class. Students are not required to view these videos, but may elect to do so as they are trying to solve similar homework problems or prepare for exams. Statistical information is shown for each metric in Table 5. As to be expected for these optional videos, viewership rates are much lower than for the required pre-class lecture videos. There are also much more significant differences between Participation, Coverage, and Full View rates, indicating that students are seeking out specific parts of these videos and usually not watching the full video.

Figure 7 shows the viewing statistics for example problem solution videos plotted versus student percentile. Several students watched almost no example problem solution videos. Only half of the students watched any portion of 10% or more of the example problem solution videos, and only 10% watched any portion of a third or more of the videos. Figure 8 shows that the viewership of example problem solution videos remains fairly consistent throughout the duration of the semester. The highest participation rates generally occur for the more complex topics covered in the course such as simple connections and analysis of indeterminate systems.

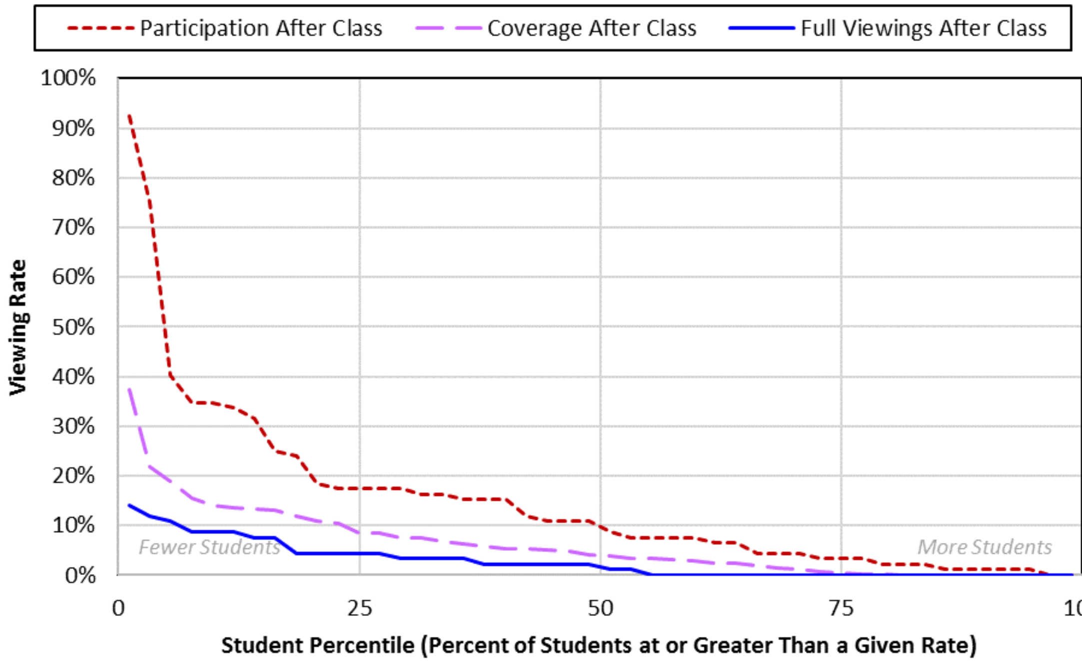

Figure 7 – After Class student viewership distribution for example problem solution videos

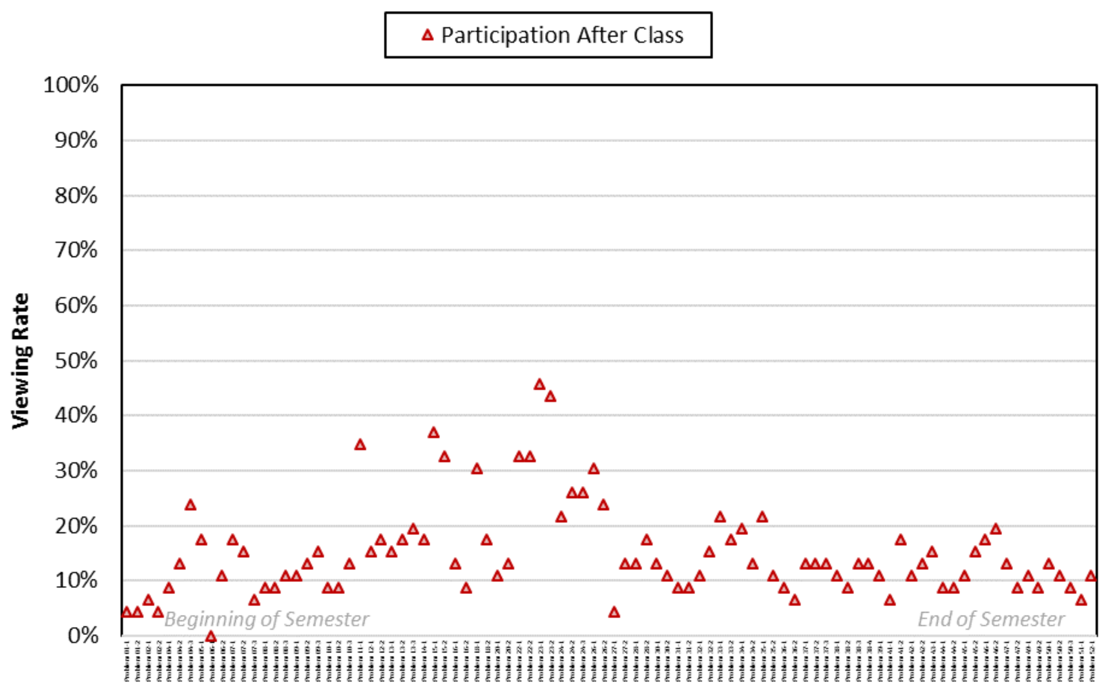

Figure 8 – Participation trends through semester duration for example problem solution videos

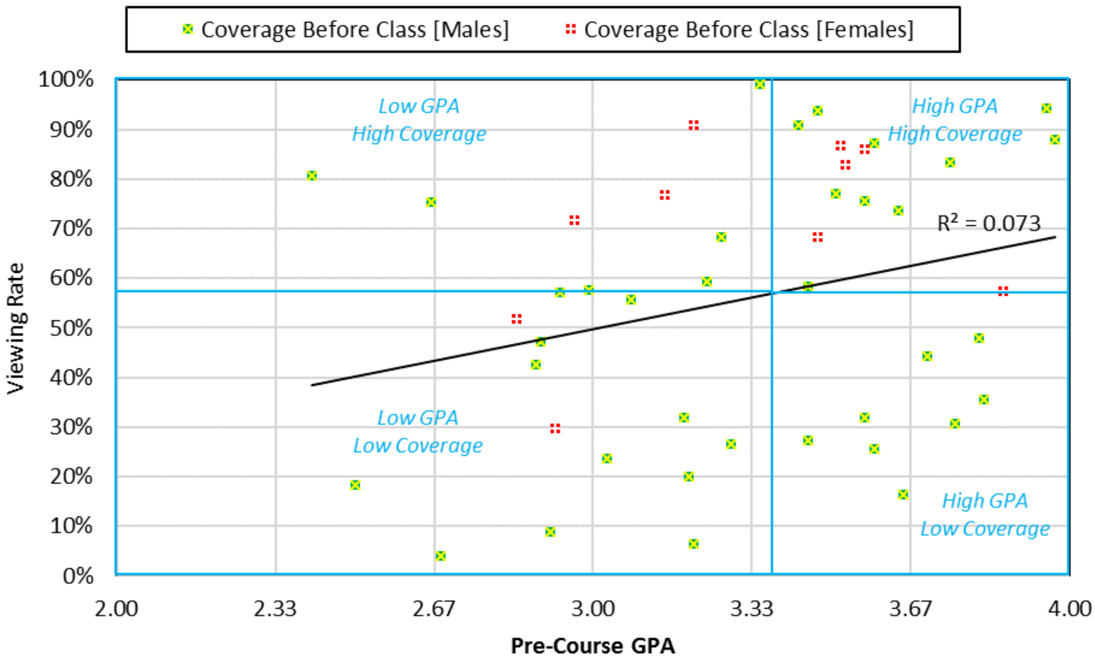

Figure 9 – Before Class Coverage statistics for theory lecture videos versus pre-course GPA

Further Evaluation of Data Based on Pre-Course GPA and Gender

Further analysis was performed to evaluate whether there was any correlation between viewership trends and identifying statistics such as pre-course GPA or gender. As can be seen in Figure 9, no statistical correlation was observed between Before Class lecture video viewing behavior and pre-course GPA. In other words, students with lower pre-course GPA's were almost as likely to watch the videos at the same rate as students with higher pre-course GPA's. The same observations can be made for After Class viewership of example problem solution videos.

The data in Figure 9 has been further separated into four quadrants using the median pre-course student GPA of 3.39 and the median Before Class Coverage ratio of 57%, and with different data point markers for male and female students. A strong majority of female students fall one of the High Coverage quartiles, indicating that females were much more likely to watch these videos. In fact, only one female student fell into the High GPA/Low Coverage quadrant and the data point corresponding to this student literally fell on the border with the High GPA/High Coverage quadrant. To the contrary, eight male students fell into the High GPA/Low Coverage quadrant.

In order to better examine the differences in overall viewership trends for male and female students, key overall statistics previously presented in Tables 4 and 5 were recomputed separately for students in each gender group. These gender-based values are shown in Table 6. Box and whisker plots are also presented for selected statistics in Figure 10. The plots clearly show the trend that female students are more likely to watch the theory-based lecture videos before class, as well as on an overall (before or after class) basis, than their male counterparts.

As indicated in the table, this difference between female and male viewership clearly meets the requirements for statistical significance. On the other hand, there is no clear statistical difference between male and female viewership for the example problem solution videos.

Table 6 – Summary viewership statistics separated by gender

	Mean (Males)	Mean (Females)	Statistical Significance (p)
# Students	$n = 36$	$n = 10$	
Before Class Viewings of theory-based lecture videos			
Participation (per video basis)	54%	76%	$p = .005$ *
Coverage (total time basis)	52%	70%	$p = .027$ *
Full Views (per video basis)	46%	65%	$p = .016$ *
Overall Viewings of theory-based lecture videos			
Participation (per video basis)	60%	82%	$p = .004$ *
Coverage (total time basis)	56%	77%	$p = .008$ *
Full Views (per video basis)	49%	72%	$p = .007$ *
After Class Viewings of example problem solution videos			
Participation (per video basis)	16%	13%	$p = .521$ **
Coverage (total time basis)	6%	7%	$p = .707$ **
Full Views (per video basis)	3%	3%	$p = .672$ **
* Statistically significant; ** Not statistically significant			

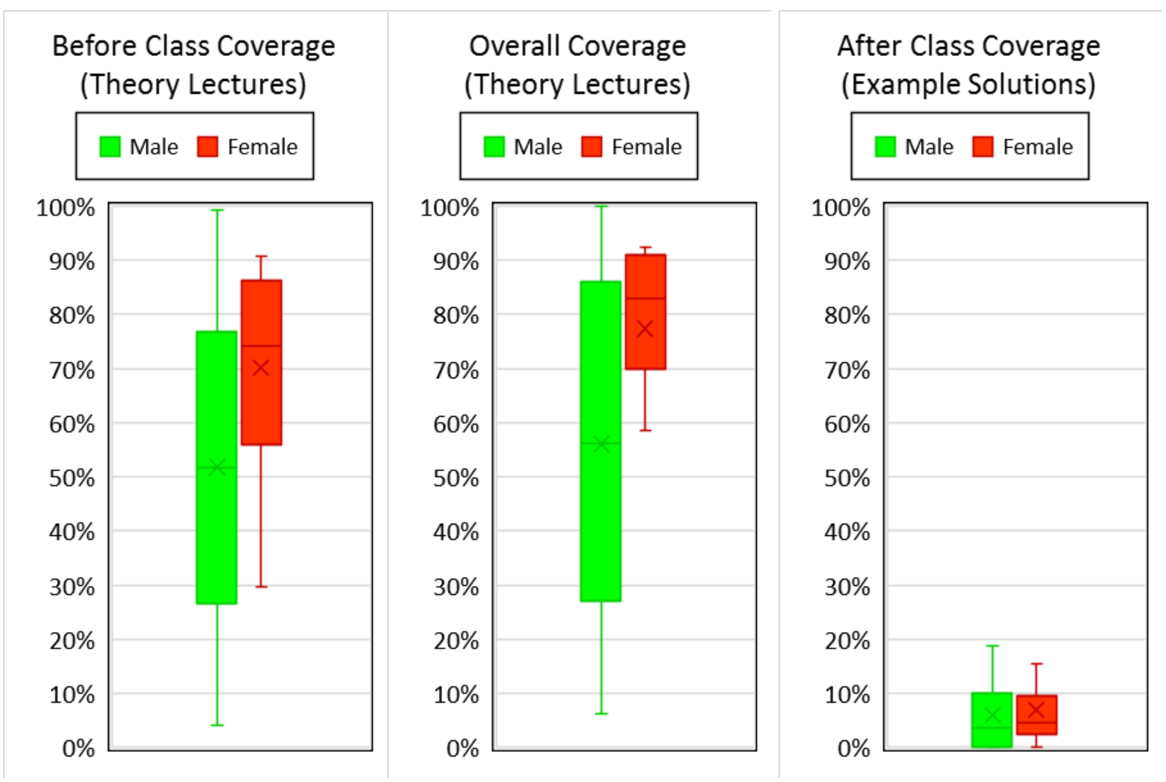

Figure 10 – Coverage statistics separated by gender groups

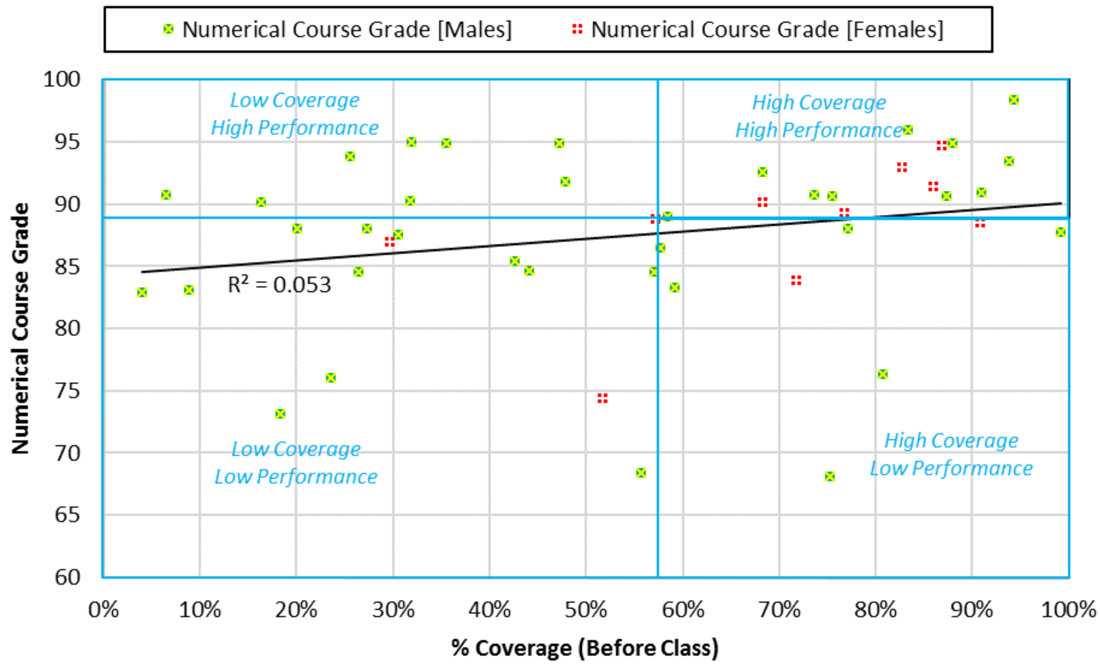

Figure 11 – Course grade versus Before Class Coverage statistics for theory lecture videos

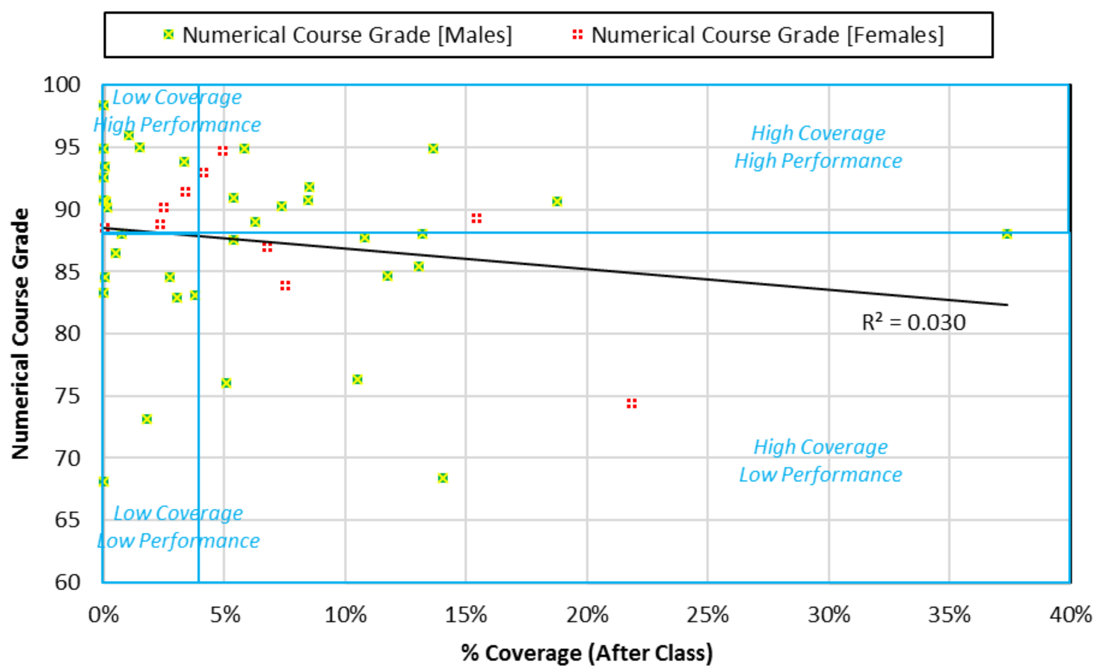

Figure 12 – Course grade versus After Class Coverage statistics for example solution videos

Correlation Between Viewership and Student Performance

The final comparisons made in this study are in many ways the most important. Figure 11 presents a plot of Before Class Coverage for theory-based lecture videos versus numerical course grade. As can be seen from the trendline and examination of the quadrants, there is no significant correlation between viewership and class performance. While there are 15 students in the High Coverage/High Performance quadrant and only 8 students in the Low Coverage/High Performance quadrant, it is worth noting that three of the top five performing students overall actually fall into the Low Coverage/High Performance quadrant.

As can be seen in Figure 12, there is also no significant correlation between viewership of example problem solution videos and student performance. In fact, the slope of the trendline (which has a very low R^2 value) actually implies that the more a student watches these example problem videos, the less likely they are to succeed in the course. Eight of the eleven students with the highest problem solution video viewership had overall course grades below the median. It can also be seen on the plot that a large number of students watched no (or almost no) example problem solution videos, and many of these students earned high numerical course grades.

Finally, Figure 13 shows that a fairly significant correlation ($R^2 = 0.508$) exists between pre-course GPA and course numerical grade. This indicates that overall past academic performance is perhaps the best indicator of the potential for success in this course. This correlation is likely even stronger than implied by this plot since the four students who withdrew from the course for reasons other than switching majors had pre-course GPA's ranging from 1.93 to 2.74. The content in this course is fairly straightforward (more advanced mechanics concepts are covered in the next course in the sequence, Mechanics II) and the focus is heavily on demonstrating an ability to solve problems. Success in freshman coursework related largely to the math and sciences should be at least a reasonably good indicator of problem solving ability.

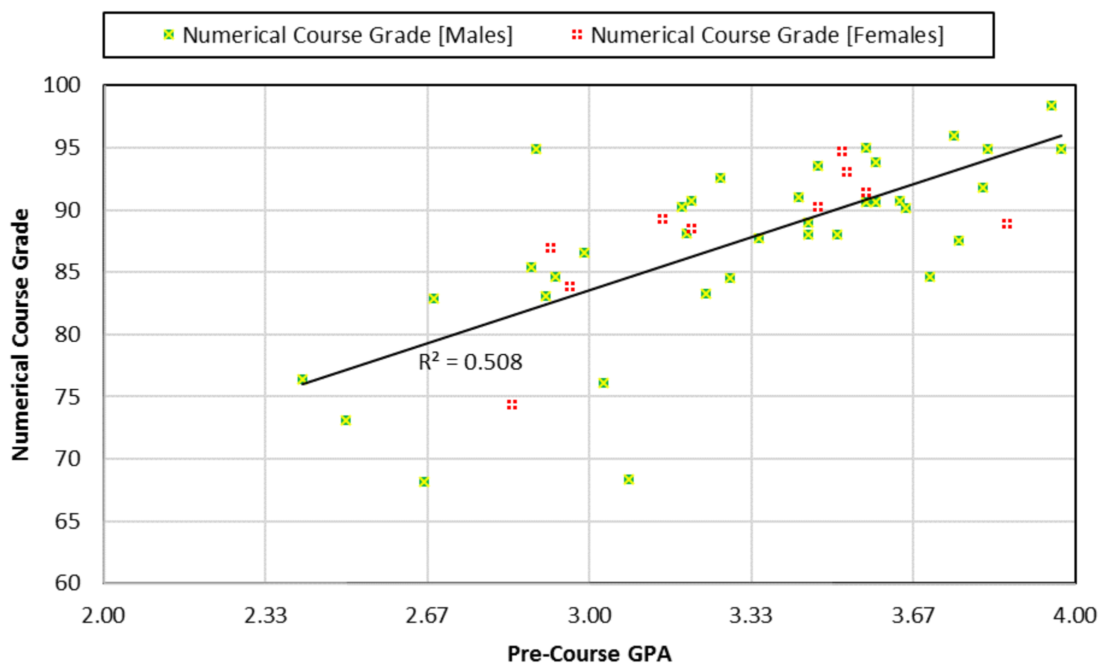

Figure 13 – Course grade versus pre-course GPA

Conclusions and Final Comments

The following conclusions reflect key observations resulting from this study:

1. Mean student Participation, Coverage, and Full View rates for viewing of theory-based lecture videos before class were 59%, 56%, and 50%, respectively for the entire course.
2. Video duration and day of week were not found to have any significant impact on before class viewership of theory-based lecture videos. Before class viewership of lecture videos decreased significantly over the duration of the semester. Coverage rates for the first, middle, and final third of the semester were approximately 75%, 60%, and 40%, respectively.
3. Overall viewing rates reported above only increase about 5% when after class views are also considered. After Class Participation for the entire semester was 13% for theory-based lecture videos, indicating a heavy concentration among a small group of students.
4. The Overall Repeat Viewing rate for theory-based lecture videos was only 2%, indicating that students did not rewind and repeat much during the viewing of these videos.
5. Mean student Participation, Coverage, and Full View rates for after class viewership of example problem solution videos were 15%, 6%, and 3%, respectively for the entire course. The significant differences among these statistics indicates that students most frequently watched only selected parts of the videos rather than the whole video. Viewership was skewed heavily toward a small group of students and several students watched almost no example problem solution videos.
6. Little to no statistical correlation was observed between student viewership trends and pre-course GPA, for either before class viewing of pre-class lecture videos or after class viewing of example problem solution videos. Students with lower pre-course GPA's were almost as likely to watch the videos at the same rate as students with higher GPA's.
7. Female students are more likely to watch the theory-based lecture videos than their male counterparts. The difference was found to be substantial and statistically significant. No significant gender-based trend was observed for the example problem solution videos.
8. No significant statistical correlation was observed between lecture viewership and course performance. Trendline slopes indicate that watching pre-class lectures may have a very small positive effect on student performance, while watching example problem videos may have a small negative effect. A relatively significant correlation ($R^2 = 0.508$) exists between pre-course GPA and course numerical grade, indicating that past overall academic performance is a strong indicator of the potential for success in this course.

The authors recognize that the significance of this study is in developing an understanding of how viewing behaviors affect student learning. The final observation stated above reflects that there was little correlation between viewership and performance (as measured by overall course grade) in this introductory mechanics course. However, these observations are based on only a single semester of data in a particular course, and may not necessary reflect the importance of similarly used videos in other courses. For example, the authors acknowledge that the conclusion indicating some students can succeed in Mechanics I without watching all of the lecture videos or any of the problem solution videos is plausible, given the relatively limited new theoretical content introduced to students in this course. A course in Reinforced Concrete Design however, entails many new concepts and a variety of applications of those new concepts, and is much less likely to be successfully undertaken by a student who does not watch the videos to prepare for problem solving in the classroom.

In many regards, the lecture videos that students were required to watch in Mechanics I are simply a replacement for reading a textbook prior to coming to class. In the past, students may have been expected to read the textbook prior to class, but they were likely not given formal credit for doing so and undoubtedly many students did not. The study presented in this paper shows that when left to watch the videos before each class on their own, some students buy in to the importance of doing so and others either do not buy in or are not able to shoulder the responsibility to do so on their own. Unlike with textbooks however, modern technology such as that used for the study reported in this paper actually permits instructors to hold students accountable for this pre-class preparation where they desire to do so, by monitoring student viewership of videos.

Although the data presented suggests no correlation between lecture video viewing rate and student performance (as measured by overall course grade), the authors would like to see higher viewership rates in the future and are strongly considering attributing a small part of the course grade toward student viewing. With so many future courses in the department using an inverted format with lecture videos, it seems appropriate to use this course as an opportunity to train students to watch these pre-class videos. Holding students accountable for coming to class prepared may ultimately be more beneficial to their performance in future coursework by teaching them that preparing for class is a vital component of the educational process.

Acknowledgements

The authors wish to sincerely thank to College of Engineering and Department of Civil and Environmental Engineering for their support of the inversion of this course. Special thanks go to the always reliable Victoria Minerva, College Coordinator of E-Learning for facilitating the maintenance of videos on the Mediasite system and for personally generating numerous usage reports. This study would not have been possible without her assistance.

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