Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #46244

# Undergraduate Engineering Students Viewership Patterns of Online Lectures for a Microcomputers Course

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## Introduction

The delivery format of college and university courses ranges from live face-to-face to asynchronous virtual delivery with a range of hybrid formats between these two. Each delivery format has different affordances (for both students and instructors). The use of asynchronous online lectures provides an opportunity for increased flexibility in accommodating students' schedules and the ability to pause and rewatch lectures at their own pace. However, this format does not include the direct interaction between instructors and students that can support social learning and provide a rich educational and social experience for students. With a broad array of delivery formats available it is important to investigate how students chose to participate in different styles, their performance after instruction using different styles, and their preference for different styles. This knowledge helps to inform instructors to decide on formats and their specific implementation for their courses.

In support of further understanding how delivery style/formats effects courses, recent works have investigated how video length can impact student engagement and performance [1], how video-viewing behavior was related to course grades (in introductory accounting courses) [2], if using videos improves performance in engineering lab courses [3], how viewing strategies of video lectures effects cognitive load [4], and overall how videos are used in online and blended courses [5]. Recently, Freeborn reported on student participation with asynchronous online lectures for an electrical engineering course focused on electric networks [6]. In this work, Freeborn reported that students who watched (mandatory) lectures less than 24 hours before weekly deadlines were not successful in the course [6]. That finding motivates this study which aims to investigate if there is a similar relationship between viewership patterns and student success for undergraduate engineering students taking a flipped-style class focused on microcomputer.

The two research questions (RQ) that this study aims to answer are:

> **RQ1:** What proportion of students watch assigned lectures more than 24 hours before their assigned deadline?
>
> **RQ2:** Do students who watch assigned lectures more than 24 hours before deadlines demonstrate greater mastery of course material than their peers who do not?

The following sections will provide a summary of the microcomputer course that is the focus of this study, the study methods, data, analysis and a subsequent discussion of the results. These details are expected to help other engineering educators in evaluating how to structure course policies regarding watching online lectures in their courses to support student performance.

## Summary of Microcomputers Course at the University of Alabama (ECE 383)

The electrical engineering course analyzed for this work was a 15-week course delivered at the University of Alabama (UA); a large, southeastern public university in the United States.

Undergraduate students in the department of electrical and computer engineering and the department of computer science at this institution are expected to complete this course in their 3rd year of study. Since 2020 this course has been offered as either an online asynchronous format (1 section) or hybrid flipped-style format (4 sections) coordinated by the same instructor. For both styles the content was delivered using pre-recorded virtual lectures, online homework and laboratory activities to provide opportunities to engage and master material. To assess individual mastery of course content after these elements cumulative examinations were required to be taken by all students. Participation with course videos was a mandatory course element with weekly deadlines for 2-3 lectures each week of the course. To encourage students to watch the lectures, 5% of the overall course grade was linked to the watch records with a minor deduction (-0.25% or -0.5%, dependent on the section) for each lecture not watched by the assigned deadline. A comparison of study performance in this course based on course format (face-to-face, asynchronous, flipped-style) has been reported [7] (with no significant differences reported).

*Online Course Videos*

The virtual lectures for this course were delivered using the Panopto platform (https://www.panopto.com/), which is integrated into the Blackboard LMS at UA. Panopto is a video platform that supports recoding, editing, and managing video content. Students were able to directly access lectures without having to navigate outside the LMS. The complete set of course lectures (37) were available within the first week of the course launch. Students were required to watch 2-3 lectures per week but could work ahead at their own pace. The course videos varied in length from 30 minutes to 60 minutes. The variation in length results from presented examples and the depth of tutorials for MPLAB software or microcontroller hardware demonstrations. During videos, examples were presented as times for students to pause and practice before resuming lectures. This resulted in fewer recorded minutes for virtual lectures than the 50-minute face-to-face lectures they were initially designed for.

To support students, a digital course notes package was provided that included the course theory and notes but had the detailed solutions to examples removed. This was to encourage participation with examples during virtual lectures and promote active engagement. A sample of a course video is given in Figure 1 to illustrate the Panopto system. Each individual video was bookmarked with descriptive labels to support students searching for previous material or finding the lecture content that aligned with the notes package examples.

Viewing of lectures was a mandatory (and graded) component of the course, though students were given flexibility in terms of when they could watch lectures. At a minimum, students had to complete viewing each week's lectures by Friday at 5:00PM. The recordings per week never exceeded the scheduled lecture minutes per week (150 minutes). Lectures were considered "viewed" if 80% or more of the total minutes were watched by the student. These details were recorded automatically using the Panopto system. This threshold below 100% was selected to accommodate potential technical issues (minutes not being captured due to an internet outage or missing minutes if students navigate to different parts of the video and miss a short segment). The percent watched of the weekly assigned videos was updated twice per week by the course instructor. The first update on Thursday each week served as a reminder to students of their

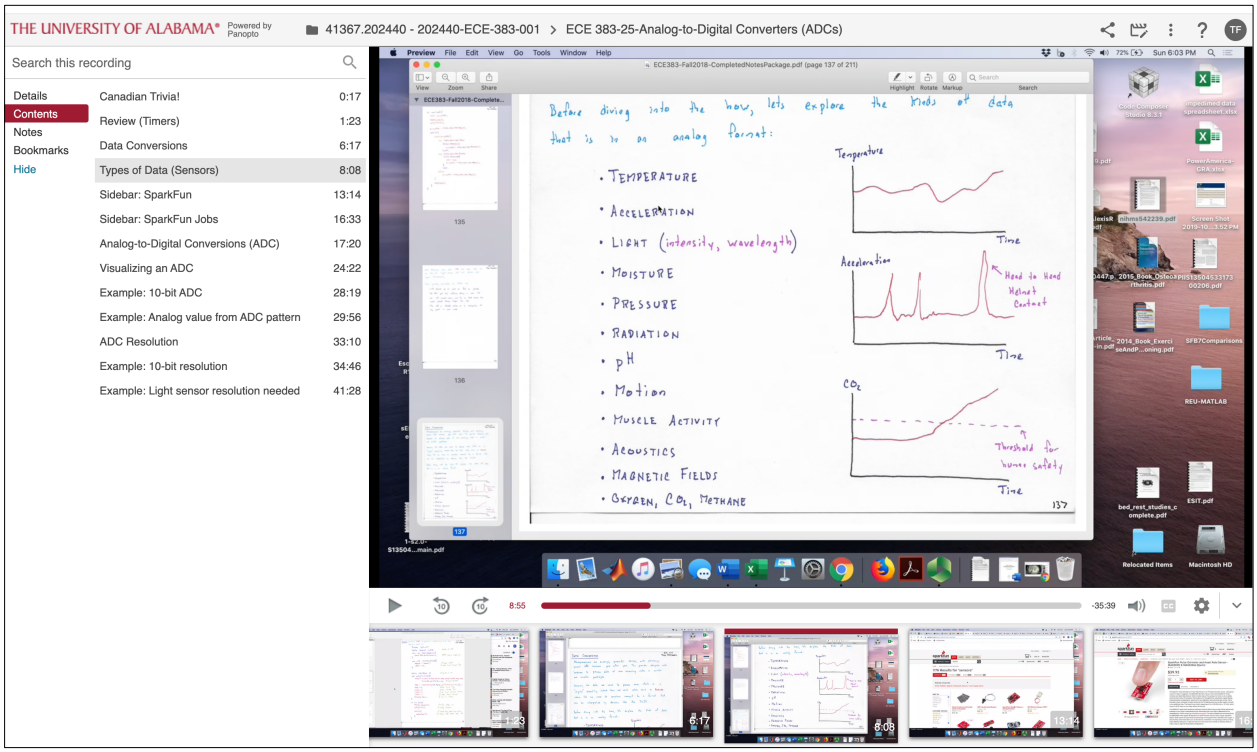


**Figure 1:** Sample online video available in Panopto platform for ECE 383.

current progress. Then, a Friday update after the weekly deadline was made with the final values for each lecture that week.

## Methods

To quantify the time before the weekly deadlines that students finished watching assigned lectures, the complete set of course records for 5 iterations (Fall 2020, Fall 2021, Fall 2022, Spring 2023, Spring 2024) were exported from Panopto for organization and analysis. These records contain timestamps when each student initiated watching each lecture and for how long they watched that session. These records were cleaned to remove records of all students who had withdrawn from the course. Overall, this resulted in watch records for 369 individual students.

Using the filtered records the last entry generated for each student to indicate their watching of a lecture prior to the deadline was flagged. The timestamps of these flagged entries were used to generate the hours prior to deadline that students watched each lecture. If a lecture was not watched before the deadline (or at all), a value of zero was assigned. Next, the median of these values was calculated to serve as a single metric of the viewing pattern for each student. The median (and not the mean) was used to minimize the effect of outliers.

To visualize lecture viewing patterns with student performance, a scatterplot of the median time before deadline and final course grade (in percent) is given in Fig. 2. Each blue circle represents one student. The x-axis is plotted on a logarithmic scale to better visualize the range of values. From this figure students have median times for watching lectures before their deadline ranging from 0.14h to 286.8h.

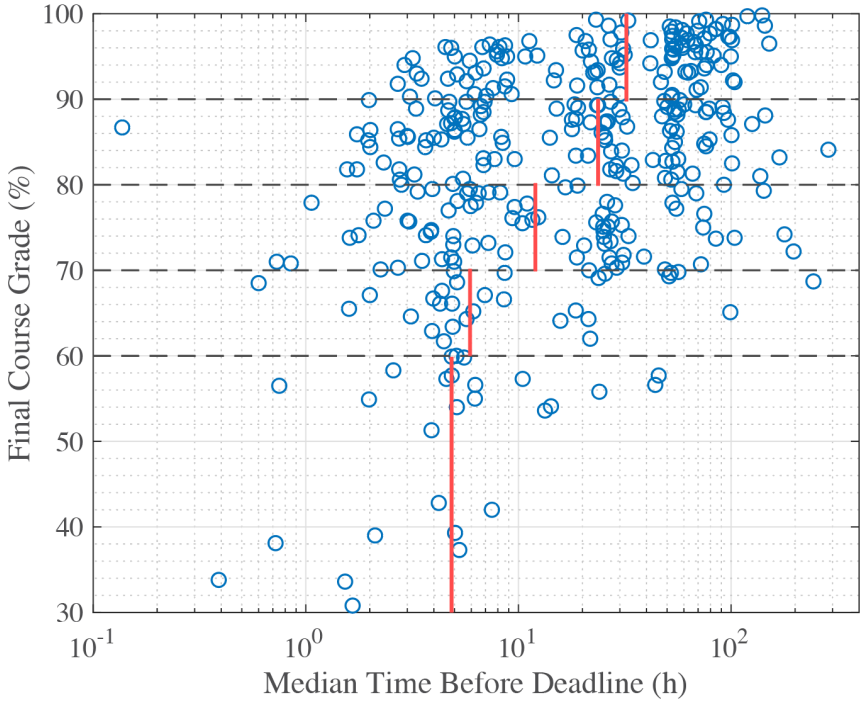


**Figure 2:** Comparison of students (N=369) median time to have watched lectures before the assigned deadline and their overall grade in the course. Dashed horizontal lines represent boundaries between letter grades. Vertical red lines represent median times for that performance group. Dashed black lines mark boundaries between performance groups for A (90% to 100%), B (80% to 89.9%) , C (70% to 79.9%), D (60% to 69.9%), and F (<60%) final grades in the course.

## Analysis

Overall, 167 of 369 students (42%) of students had median watch metrics greater than 24 hours, answering the first research question that motivated this study (RQ1: *What proportion of students watch assigned lectures more than 24 hours before their assigned deadline?*). To answer the second research question (RQ2: *Do students who watch assigned lectures more than 24 hours before deadlines demonstrate greater mastery of course material than their peers who do not?*) the median final grades for both groups were generated. The median final course grade for students who finished the course videos >24h before the assigned deadlines was 88.2% (B+). For comparison, the students who finished course videos <24h before the assigned deadline (202 students) had a median final grade of 81.1% (B-). This supports that students who are engaging with course material (through the online lectures) well before deadlines are performing better in the course than their peers who do not.

To further evaluate the patterns of viewing records based on performance levels in the course the median times before deadline, average times before deadline, median missed lectures, and average missed lectures were calculated for the groups of students with final course grades of A, B, C, D, and F. These values are all reported in Table 1. While +/- grades are given in the course they are grouped together here (e.g. A+, A, A- are treated as the A performance group, B+, B, B- are treated as the B performance group, etc.)

**Table 1:** Course video viewership metrics grouped by final course performance

| Final Course Grade | Count | Median Time Before Deadline (h) | Average Time Before Deadline (h) | Median Missed Lectures (#) | Average Missed Lectures (#) |
|---|---|---|---|---|---|
| **A** (90% to 100%) | 114 | 32.71 | 43.54 | 1 | 1.51 |
| **B** (80% to 89.9%) | 119 | 23.70 | 34.79 | 2 | 2.84 |
| **C** (70% to 79.9%) | 78 | 12.01 | 26.48 | 2 | 3.54 |
| **D** (60% to 69.9%) | 30 | 5.92 | 23.96 | 5 | 5.67 |
| **F** (0% to 59.9%) | 28 | 4.85 | 8.1 | 9 | 9.21 |

General trends from this data include that higher performing students have higher median watch metrics (e.g. they are watching lectures a day or more before the deadlines) and are typically failing to watch only 1 lecture before assigned deadlines through the entire semester. By comparison, students who are not successful in the course (e.g. earning a grade of D or F) have a median watch metric <6 hours and are missing up to 9 lectures (representing ~24% of the course content).

Both the median and mean values are presented in Table 1 to illustrate the differences between these two approaches to generating the viewership metrics. For both time before deadline and average missed lectures, the mean values are greater than the median. But this difference is far greater than for the average time before deadline metric. This is attributed to cases where students (intentionally or unintentionally) watched only a few lectures well ahead of the deadline (weeks or more). Because these few cases can distort the overall viewership pattern, the median value is selected as the metric for comparison.

## Discussion

Approximately 42% of students in ECE 383 completed watching the assigned course videos > 24 hours before the weekly deadlines, and the median final grade of this group was approximately 7.1% higher than their course peers who did not. Further, comparing viewership patterns of students by their overall performance suggest that the highest performing students' complete lectures approximately 32 hours before the deadline, while the lowest performing students complete them less than 6 hours before the deadline. This suggests that students who are performing poorly in the course are "binge watching" up to 150 minutes of lecture content on the day of the deadline and/or failing to watch the lectures at all (as evidenced by median values of 9 missed lectures for students who earned an F). Similar results were reported by Freeborn in an analysis of performance/viewership records for an asynchronous electric networks course [6]. Freeborn reported low levels of success for students who watched course videos less than 24 hours before deadlines [6].

Goedl et. al also reported that students final course grades and percentage of videos viewed were related in an online, asynchronous accounting course [2], noting that if students view 10% more of the course videos, they were expected to raise their final grade percentage by 2.5%. These

works together (unsurprisingly) suggest that student performance in courses with required video lectures is related to their viewership patterns. That is, not only is it important that students watch the videos but also watch them with sufficient time to process and understand, have time to seek opportunities for clarification, and have time to practice applying the concepts from the video to increase mastery of them.

It is hypothesized that students who watch multiple lectures in a short period of time may struggle to deeply understand and retain content knowledge from the video lectures without time to seek clarification from the instructor before assignments or exams. While this study cannot evaluate that hypothesis, if true, then changes to how video lectures are assigned could encourage students to limit this type of engagement. Specifically, individual deadlines could be set for each lecture each week (e.g. Monday, Wednesday, and Friday by 5PM) instead of a single deadline (e.g. Friday by 5PM). Though this may also reduce the flexibility that has been previously reported as beneficial by students in this course in previous analyses of the flipped-style experience [7].

*End of Semester Student Survey*

Feedback regarding the course in the Fall 2022, Spring 2023, and Spring 2024 iterations was solicited from the students through end-of-semester surveys (administered by Blackboard) using a mix of multiple choice, Likert scale items, and open-ended questions. These surveys were completed in the final week of the course by enrolled students. One of the survey questions asked students to rate how helpful the pre-recorded lectures were in managing their own schedule. The complete set of student responses to this question are detailed in Table 2.

**Table 2: For the lectures this semester, was having them pre-recorded helpful to manage watching them on your own schedule?**

| Response | Fall 2022 (N=51) | Spring 2023 (N=81) | Spring 2024 (N=80) |
|---|---|---|---|
| Very Helpful | 56.9 | 54.3 | 48.8 |
| Helpful | 15.7 | 21.0 | 17.5 |
| Neutral | 19.6 | 6.2 | 13.8 |
| Not Helpful | 0.0 | 0.0 | 3.8 |
| Prefer "Live" | 5.9 | 16.1 | 16.3 |
| Not Answered | 2.0 | 2.5 | 0.0 |

Generally, more than 66% of respondents rated the pre-recorded lectures as *Very Helpful* or *Helpful* for managing their own schedule; highlighting the majority of students appreciated this approach for the course. Though it is important to highlight that this approach is not universally appreciated. Up to 16% of respondents reported preferring live lectures and not the pre-recorded style.

For many of the open-ended questions, students commented about the online videos. This provides further insight into their experiences that were not captured in the responses of Table 2. A sample of responses that mentioned the recorded course lectures with both positive sentiment and negative sentiment are provided in Table 3, along with the questions that served as the prompt.

**Table 3.** Samples of student responses to anonymous class survey prompt: "Considering your experiences with the work periods this semester was the high-level of flexibility a strength or weakness in this course for you? Compared to your other courses this semester, did you like this delivery format better or worse?"

***Statements with positive sentiment on recorded course lectures***

- The high level of flexibility in this class was quite beneficial to me, as I was able to pause the lectures and move at my own pace when copying notes down. This semester was also quite busy for me, so it enabled me to watch the exams at more manageable times than an in-person lecture would allow. In some ways I prefer this delivery format to my other courses - that being said - I would not like all of my classes to be formatted like this, as I think it does take some human and "classical college education" element out of it.
- I enjoyed being able to watch all of the lectures at the beginning of the week (Sunday/Monday) and having the rest of the week open to do the homework and labs.
- Prerecorded lectures are the best. Never stop please.
- I liked this format much better than other classes, mainly because being able to pause a lecture is so much more helpful than you would think. You can't always go at the same pace as everyone else, so it's nice being able to speed up through parts you feel confident with and slow down with newer or more difficult information.
- The high-flex and fully online (mandatory!) lectures were my favorite part of the course. I am the student who never attends any class unless there is an exam, quiz, or attendance is graded, because I am very tired often and struggle with stress/ mental issues and ADHD. This means when course material is not online, I have to read the textbook directly to learn all the material, which is not always optimal, but it gets me passing grades. I absolutely love the online lecture videos. I did not always actually watch them, but I tried to, and when I did I would put them on 1.5x or 2x speed and I actually enjoyed them and was able to pay attention and engage with the material. Plus, when doing homework or studying, it was so easy to go to the relevant video and jump to the part I needed to rewatch it and see an example or grab a piece of info. I wish all of my classes were this format.
- It was probably the best course experience I have ever had. I have never had a class be run like this and I loved it. It really helped with my comprehension of the material because sometimes I understand things more slowly or quickly, so I could pause when I needed it to understand and speed up when I understood to avoid getting bored.

***Statements with negative sentiment on recorded course lectures***

- I would prefer live lectures during class. I just learn better that way. I know a lot of people prefer the videos though.
- I tried to keep up with watching my lectures but it was very easy to let them add up which left me watching multiple videos at one time. Compared to my other classes this semester I can say that I liked the recording but they weren't the best way for me to learn. I feel like having the videos as an option to watch would be nice (if you miss class or want a refresher) but I feel like for those who can't learn with videos having a "live" lecture option would be beneficial.
- I feel that I would retain information better from an in-person lecture rather than watching course videos, but the convenience of watching them whenever I wanted was nice nonetheless.
- Weakness. I find it harder to stay awake while watching a video opposed to giving a real person my attention.
- I didn't like feeling like it was my responsibility to teach myself the course content despite the fact that I was attending the class period. The videos are a neat concept, but it was too easy to avoid actually watching them and then fall behind in content, which only led to even more videos being skipped. I think this would have been less of an issue if I felt like I still had a passing knowledge of the content that a skipped video

| |
|---|
| covered (i.e. because it was also covered partially in class) and then I would have had less of an issue still watching the next video in the sequence.<br>• I can find it difficult to self motivate, meaning doing things "on my time" can lead to them not being done until unnecessarily close to the deadline. |

The two common themes that emerged from student responses with positive sentiment were that **i)** students appreciated the flexibility with when they could watch the lectures, **ii)** the ability to manage how lectures are watched (e.g. pausing, repeating, slowing down, speeding up) was viewed as helpful. The common theme that emerged from student responses with negative sentiment were that students struggled with the executive function (e.g. planning, focusing attention, remembering, and balancing multiple tasks) and self-regulation (e.g. resisting impulses) required for this format and preferred live lectures as a result.

These results align with reports of Kim et. al in their analysis student's study behaviors for live online lectures and pre-recorded lectures during COVID-19 [8]. Kim et. al reported that students who reported higher levels of restraint from distractions (such as social media and texting) while listening to online lectures evaluated them more favorably. The student comments with negative sentiment in Table 3 suggest low levels of restraint (e.g. finding it hard to focus on them, hard to stay awake, difficulty self-motivating). For the future of this course (and other courses using video lectures) it would be interesting to explore if integrating methods to improve students' self-regulation and metacognition (such as those proposed by Cunningham et. al [9] or Ostafichuk et. al) will improve viewership patterns and student performance. Similarly, it would be interesting if presenting the results of this study to future cohorts would influence their viewership and performance.

A limitation of this work is that the viewership metric (hours before deadline) does not capture engagement nor does it capture students viewing of lectures after a deadline. Both of which are expected to be associated with student performance. It is possible that students play the video lectures but do not watch them or engage in other activities and do not focus on them. In this case, it is possible to have a high hours before deadline metric, but low course performance. It is also possible that high performing students miss the deadlines, but watch videos afterwards and engage deeply in them while watching (e.g. completing all examples, following up with assigned readings, then attending work periods for additional support). This could result in a low before deadline metric for that student but a high course grade. Future research should investigate other metrics and combinations of metrics (e.g. engagement, time before deadline, minutes watched after deadline) that may better model the relationship between viewership and performance.

## Conclusion

Approximately 42% of undergraduate engineering students in ECE 383 completed watching the mandatory course videos more than 24 hours before the weekly deadlines. For this group of students, the median final grade was approximately 7.1% higher than their course peers who tended to watch lectures less than 24 hours before the weekly deadlines. Further, comparing viewership patterns of students by their overall performance suggest that the highest performing students' complete lectures approximately 32 hours before the deadline, while the lowest

performing students complete them less than 6 hours before the deadline. Student feedback indicate most students find the use of online lectures (for this class) helpful for managing both when and how they engage with the course. Those students who reported negative sentiments were often attributed to struggles with self-regulation.

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