Student Participation with Asynchronous Online Lectures for an Electric Networks Summer Course in the COVID Pandemic

Todd J. Freeborn
Dept. Electrical & Computer Engineering, The University of Alabama

Abstract

Asynchronous online lectures provide an opportunity for increased flexibility in accommodating students schedules and the ability to pause and rewatch lectures at their own pace. During the Summer 2020 semester, a 10-week course on electric networks was delivered entirely using asynchronous virtual lectures and online homework/projects with weekly virtual office hours in response to the COVID pandemic. Participation with lectures was a mandatory (and graded) course element with weekly deadlines for each set of lectures. A quantitative analysis of student patterns of engagement with the asynchronous lectures during this summer course in the COVID environment and their relationship with course performance are presented.

Keywords

Undergraduate Education, Electrical Engineering, Electric Networks, Asynchronous Lectures

Introduction

During the Spring 2020 semester, Universities around the nation and the world transitioned rapidly to virtual learning in response to the COVID-19 pandemic. This transition saw a massive and rapid shift from face-to-face instruction to virtual instruction in both synchronous and asynchronous formats. The impacts of this rapid shift on students learning experiences and learning outcomes is of significant interest and investigation across disciplines. Recent studies have reported the impacts of this transition at a Hispanic-serving institution[1], detailing lessons learned from teaching cybersecurity courses[2], detailing student experiences[3,4] and student adaptation[5] during this time, and comparing synchronous and asynchronous delivery of physics courses[6] . While this is not a comprehensive review of the recent research that is emerging, it does highlight the range of studies/reviews that are being conducted.

As engineering educators continue to adapt their courses to respond to the changing education landscape caused by the COVID-19 pandemic, it is important to explore how to implement course policies and structures that accommodate students' needs balanced by the course learning objectives and semester timelines. Consider asynchronous lectures which provide the flexibility for students to review the content at times that best fit their schedule. However, lectures and course content must be viewed with sufficient time ahead of assignments, projects, or exams for students to master and apply the course concepts. Without sufficient time, students may not be able to engage with practice problems related to the course material or connect with instructors for support; both of which could lead to poor performance in the course.

The aim of this research is to quantify electrical and computer engineering students engagement with asynchronous course lectures in a 10-week summer course and the relationship of this

engagement with overall course performance. Additionally, student feedback regarding the course and asynchronous lectures is reviewed to further understand student experiences with this format.

Course Background

During the Summer 2020 semester, a 10-week course (May 27, 2020 to July 31, 2020) on electric networks (ECE 326) was delivered for electrical and computer engineering (ECE) students at the University of Alabama (UA). This course is a degree requirement for all ECE students and is recommended to be taken during their junior year. The material that is included in this course includes: response of circuits to transient signals (deterministic and random), Laplace transform solution techniques for circuits and differential equations, relationship between Laplace and Fourier transforms, frequency response and representation of circuits and systems, and modeling of uncertainty in circuit elements.

Summer 2020 Iteration

ECE 326 has traditionally been delivered using synchronous face-to-face instruction. In response to the COVID-19 pandemic and recommendations to maintain social distancing and limits to face-to-face interactions, this course was transitioned to virtual delivery for the Summer 2020 semester. This transition to a virtual course included asynchronous virtual lectures, online homework/projects, and twice weekly virtual office hours with the course instructor. The course format of delivery was noted prior to the semester start during the registration period, so students that did enroll were aware of the format prior to the course start. During the 10-week course, students were required to watch the online lectures, complete online assignments (10 total), and complete course projects (3 total) administered using the Blackboard learning management system (LMS). Final grades were based on virtual attendance (5%), assignments (15%), and projects one (15%), two (25%), and three (40%). The use of projects instead of timed-exams for Summer 2020 was in response to the potential challenges during a period where students were not on campus and may not have had access to reliable and robust internet. For this iteration of the course, a total of 47 students registered, but 4 withdrew prior to the end of the course. For this work, only the records of the 43 students who completed the course are analyzed.

Asynchronous Lectures

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 and also provides tools for measuring engagement. Students were able to directly access lectures without having to navigate outside the LMS. The complete set of course lectures (37) and online assignments were available within the first week of the course launch. At a minimum, students were required to watch 2-4 lectures per week (with an average of 4 per week, but 2-3 for the shortened weeks at the start and end of the course) but could work ahead at their own pace. Failure to watch an assigned lecture by Sunday (11:59pm) of each week resulted in a 0.25% deduction from their attendance grade in the course. The course videos varied in length from 19 minutes to 54 minutes (with an average length of 34.5 minutes). Each delivered lecture was based on material developed by the instructor during 2 previous iterations of this course (in Spring 2018 and Spring

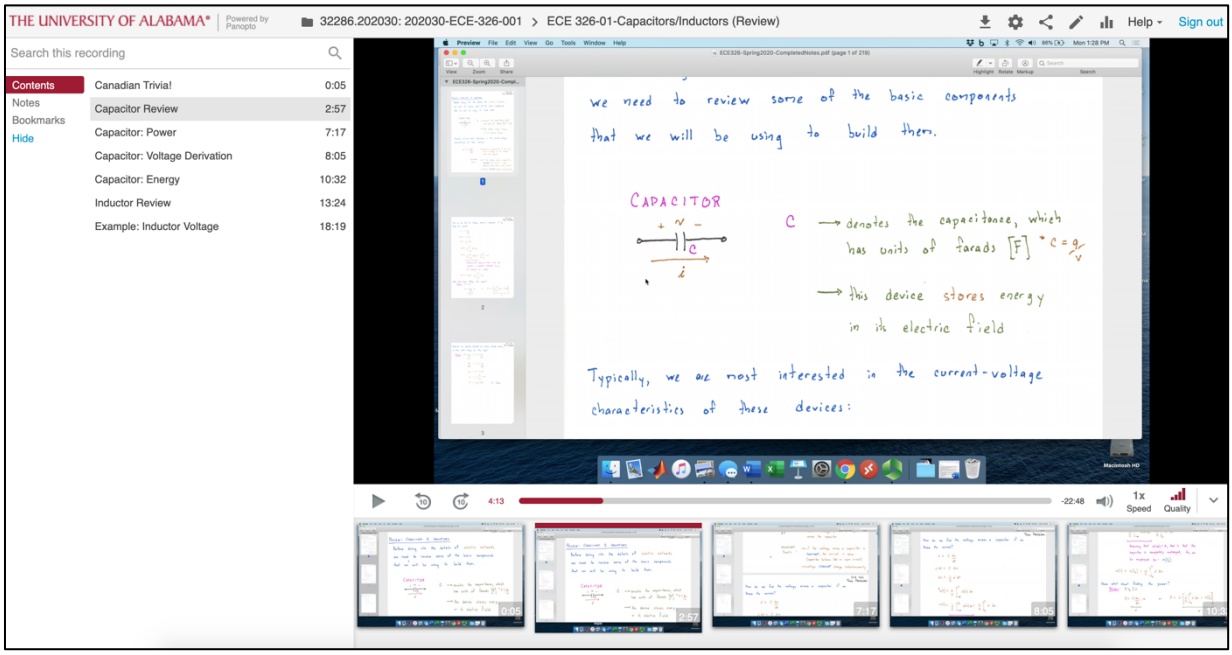

Figure 1: Sample virtual lecture in Panopto system for ECE 326 during Summer 2020 iteration.

2019). The variation in lecture length was an artifact of the number of presented examples per lecture and the depth of tutorial for MATLAB and LTSpice software (added as supplements beyond the typical material covered during in-person instruction in previous semesters). During semesters with face-to-face instruction, examples were done during class time but in the virtual lectures these moments 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 Sunday at 11:59PM. Students were encouraged in weekly check-in emails to watch the lectures during the scheduled course time (MWF, 12:30pm to 1:45pm). The recordings per week never exceeded the scheduled lecture minutes per week (225 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 Friday each week served as

a reminder to students of their current progress with a Monday update after the weekly deadline with the final values for each lecture that week. Each set of weekly lectures were to prepare students for an assignment on that lecture material that was also due on Sunday at 11:59PM.

Methods & Results

Asynchronous Lectures Viewing Patterns

To quantify student viewing patterns of the asynchronous lectures, the complete set of course records was exported from Panopto for organization and analysis. These records contain timestamps of when each student initiated watching each lecture and for how long they watched for that session. These records were cleaned to remove records of all students who had withdrawn from the course and limit entries for further analysis to only those with >5 minutes of watching. 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 (HPD) for each lecture. If a lecture was not watched before the deadline (or at all), a HPD of zero was assigned. From the complete set of lecture HPDs, an average (mHPD) was generated as a single metric to represent the watch pattern for each student. A lower mHPD indicates that students are watching lectures closer to the final deadline.

To visualize lecture viewing patterns (represented by mHPD) with student performance, a scatterplot of mHPD and final course grade (in percent) is given in Fig. 2. Each blue circle represents the performance of one student in the course. The x-axis is plotted on a logarithmic scale to better visualize the range of mHPD values. From this figure students have mHPDs ranging from 6h to 368h. Two vertical red lines and one horizontal red line have been placed on Fig. 2 to break it into 6 segments (Q1-Q6). The vertical lines represent mHPD values of 24 hours and 48 hours while the vertical line represents the pass/fail threshold in the course. These thresholds represent patterns of viewing lectures on the day of the deadline or the weekend of the deadline and not during the week. Students in Q1-Q3 earned a passing grade in the course (A, B, C) while students in Q4-Q6 earned a D or F. The D or F grades are grouped because students require at least a C- to be eligible for classes that require ECE 326 as a pre-requisite. From these segments, notice that there are no students who earned a passing grade with mHPD < 24h and that 4 of 9 students with 24h < mHPD < 48h did not earn a passing grade. For comparison, only 7 of 31 students with mHPD > 48h did not earn a passing grade. This highlights that higher proportions of students who did not earn a passing grade in the course were engaging with the lectures much closer to the weekly deadlines. Students who consistently watched the lectures on Monday, Wednesday, and Friday during the class hours would have a mHPD of approximately 105h. Therefore, mHPD < 105h may be an indicator of students who are not viewing the lectures as recommended in the course. Notice also that the cluster of the highest performing students, receiving grades > 98% (an A+ in the course) have mHPD > 265h. Indicating this cluster worked through the course material at an accelerated pace (almost 2 weeks ahead of the planned course schedule).

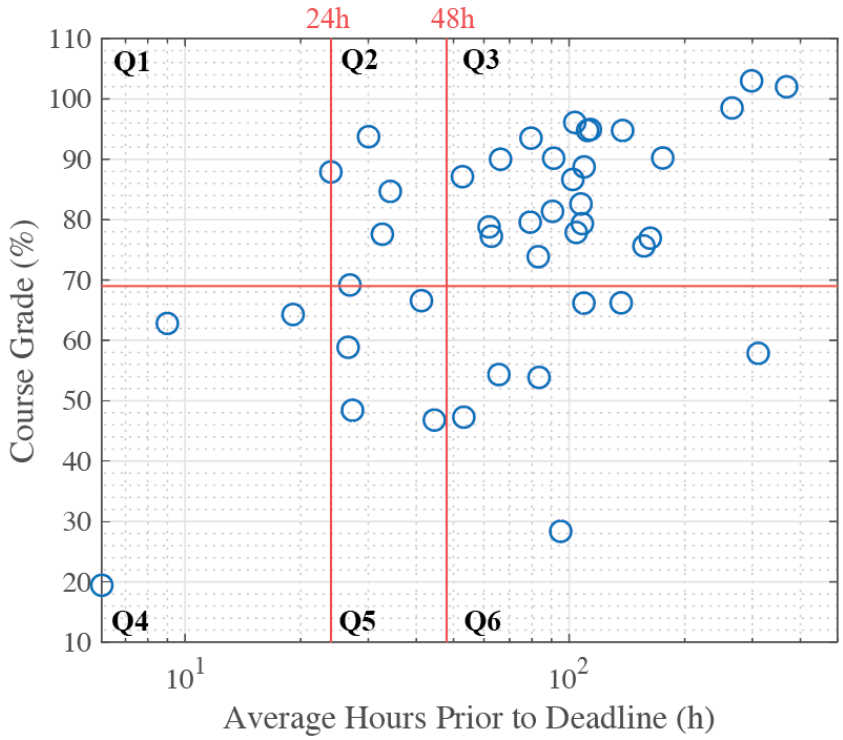

Figure 2: Scatterplot of student's final course grades vs. the average hours prior to deadline that weekly course lectures were watched. Students in Q1-Q3 earned passing grades in the course (A,B,C) while students in Q4-Q6 earned a D or F.

End of Semester Student Survey

Feedback regarding the asynchronous lectures was also solicited from the ECE 326 students through an end of semester survey (administered through Blackboard). This survey was completed in the final week of the course by the enrolled students. It had 24 questions that were a mix of multiple choice, Likert scale items, and open-ended questions. A total of 34 students (79% of enrolled students) completed the survey and all received responses were anonymous. Two Likert scale questions were asked to get feedback on students' opinions of how virtual lectures helped them manage their schedule and their self-reports of how they approached watching the online lectures. The specific wordings of these questions and the summary of responses are detailed in Table 1.

Table 1: Likert-Scale questions from course survey regarding virtual lectures

Question:	Very Helpful	Helpful	Neutral	Not Helpful	Prefer "live" virtual classes	N/A
For the virtual lectures this semester, was having them pre-recorded helpful to manage watching them on your own schedule?	76.5% (26)	14.7% (5)	2.9% (1)	2.9% (1)	0% (0)	2.9% (1)
	Option 1	**Option 2**	**Option 3**	**Option 4**	**Option 5**	
Select the answer that best represents your approach to watching the online lectures:	17.6% (6)	44.1% (15)	11.8% (4)	17.6% (6)	8.8% (3)	

Option 1: I watched the lectures faster than the regular course pace, getting a week or more ahead
Option 2: I watched a lecture every 1-2 days, completing each week's viewings by Friday
Option 3: I watched all lectures in 1-2 days at the end of the week, but completed them all by Friday night
Option 4: I watched all the lectures on either Saturday or Sunday before the final weekly deadline
Option 5: None of these responses captures how I watched the lectures

More than 90% of students reported that asynchronous (pre-recorded) lectures were helpful or very helpful to managing their schedule, supporting that this approach benefited the students. The self-reports of the students approach to watching the lectures do align with the Panopto reported data. Approximately 7 students have a mHPD > 168h in Fig. 2, aligning with the reports from 6 students that they watched the lectures faster than the regular course pace, getting a week or more ahead. While the number of students who self-reported watching all lectures on Saturday or Sunday each week (6) is lower than the 11 reported in Fig. 2, this may be an artifact of the number of students who completed the course survey.

For many of the open-ended questions, students commented about the virtual and online aspects of the course. This provides further insight into their experiences that were not captured with the Likert scale items. All responses that mentioned the virtual/online aspects of the lectures are provided in Table 2, along with the questions that served as the prompt.

Table 2: Open-ended questions regarding ECE 326

What were your favorite parts of this course? What topics or examples did you find most interesting? Were there topics you wished we covered in more detail? What would you want to remain the same if this course was run again?
"My favorite part of the class for me was the full online learning experience. I feel this way because even though the lectures were online it still felt very personal i.e the Canadian trivia. I just feel that was a good way to start a class instead of jumping right into the daily college grind."
"I liked how the lectures were very clear and easy to understand. Also really enjoyed watching them at 1.5x speed (no offense)."
"I really liked how I could go through each lecture at my own pace, pausing when I needed to."
"The ease of having flexibility with the lectures allowed me to focus on my two other classes and mange those workloads since they had set meeting times. If the course were run again keep that aspect and student's lives will be made easier."

Table 2: Open-ended questions regarding ECE 326
What were your least favorite parts of this course? What would you suggest be changed if this course was run again? Were there aspects of other classes that you really liked that you think could be adopted here to improve your experience in this course?
-"The pre-recorded lectures were nice for self-pacing, but I like my live classes better because if I have a question, I can ask it right then and I think that helps me understand the material better." -"I think having lecture watching deadlines throughout the week that aligned with the scheduled class times would have helped with remaining on schedule. Since we received emails that you could track a good number of students watching lectures at the last minute, maybe if one lecture was due Monday night, one Wednesday night, one Friday night and another Saturday night."
With the continuing COVID-19 crisis and implementation of virtual lectures for the summer, do you feel you were given enough materials and access to resources to be successful in this course? Do you have any comments or suggestions on what worked well for the course or suggestions for what could be improved?
"Prerecorded lectures are much better than a zoom call as you can go back over the material if something is missed." "I cannot stress enough how useful it was to have the lectures prerecorded. Between moving twice, a beach trip, and more family encounters than I cared to attend, the lectures were a godsend." "From a learning perspective, I think it is much more efficient to learn in a completely virtual course such as this one since you can work completely at your own pace and have complete access to rewatch videos. I learned a lot from this course and really can't imagine learning more if it were in person. The only reason I would prefer in-person classes still is because of the human interaction element that is missing from virtual courses. I think weekly office hours were great for adding this element back in though." "I feel as though virtual lectures made this course somewhat more difficult. I would definitely recommend direct student/professor interaction for this course in the future. Maybe having scheduled Zoom lectures instead of prerecorded lectures." "I was surprised how effective this class was despite being a virtual course." "The lectures being available at the beginning of the course was also very beneficial and worked for my schedule." "I thought that your video lectures were very useful in explaining almost everything we learned in class and gave us good examples to practice with" "I vastly prefer online recorded lectures to anything real time. Being able to rewatch explanations of the material is worth far more than any notes I have ever taken."

From those students who did respond to the open-ended questions, there was very positive experiences with asynchronous lectures and the affordances they offered in terms of pacing, scheduling, and rewatching material. Students who expressed their preference for synchronous lectures often mentioned a desire for direct interaction with other students and the instructor.

Discussion

From the analysis of the viewing patterns, the most significant results in terms of building course structures to support student success are:

- All students with a mHPD < 24h were not successful in the course and;
- A higher proportion of students with mHPD < 48h were not successful in the course.

This pattern of viewing lectures prevented students from attending virtual office hours for support with lecture material and created a significant time pressure to complete the weekly assignments. This may indicate that students who struggle with self-regulated learning may benefit from a change in the course structure such as revising the lecture viewing deadlines. In fact, a suggestion for a revised structure with individual deadlines of Monday, Wednesday, Friday, and Saturday for the weekly lectures was provided in the open-ended survey questions

from a student. This revised approach would still provide flexibility for students for when they watch lectures, it would not limit students working at an accelerated pace, and would accommodate students who may benefit from increased structure. Further, revising the weekly lecture deadlines so that they are due prior to the assignment deadline (and not sharing the same deadline) may encourage earlier student engagement and increase student performance. Both of these revisions are minor structural changes in the course that warrant future implementation and analysis of the impact on student performance.

Another structural change that could improve student experiences for those who reported a desire for human interaction and rapid response to questions would be moving virtual office hours to overlap with the scheduled course time. For the Summer 2020 iteration, virtual office hours using the ZOOM platform were offered on Thursday (12pm to 1pm) and Friday (2pm to 3pm) each week. Virtual office hours were not during registrar scheduled course times (MWF, 12:30pm to 1:45pm) to encourage students to watch lectures during the course hours and then provide support at the end of the week prior to the weekly assignment deadlines. However, offering the virtual office hours that overlap with the scheduled course times could provide an opportunity for students to directly ask questions while working through the asynchronous lectures. This would have the added benefit of limiting scheduling conflicts with other classes.

While this work has utilized the mHPD metric to quantify student viewing patterns, this metric is limited in that it does not capture how students are engaging with lectures. For example, students may have started lectures and let them run in the background while doing other tasks or not even watching at all. With this approach, students could have a high mHPD but low course performance because there was limited active engagement. This could be the case for students in Q6 of Fig. 2. Further, the approach to generate HPD here does not differentiate between a student who has watched a lecture more than once (with the final viewing being near the weekly deadline) and a student who only watched once near the deadline. Both cases would generate a similar HPD, even though a student who watched multiple times has higher engagement. This may account for the range of student performances with mHPD that fall within the range of 24h < mHPD < 48h in Fig. 2 (Q2 and Q4). Some students may be rewatching lectures to support their completing of assignments, leading to strong performances in the course. Future analyses should explore metrics beyond mHPD that include the number of times a lecture is watched, as well as the number of times a lecture is paused (which could indicate working through in-lecture examples prior to continuing with the lecture). Both of these actions may indicate higher student engagement and may be associated with high performance and material mastery. Though this requires further investigation to test this educational hypothesis.

References

1 Shapiro, M., Solano, D.M., Bergkamp, J.J, Gebauer, A., Gillian, E., Lopez, K.M., Santoke, H., Talbert, L.E., "Impacts of converting courses to virtual instruction midsemester at a Hispanic-serving institute," J. Chem. Educ., vol. 97, pp. 2526-2533, 2020.

2 Bai, Y., Gao, C., Goda, B., "Lessons learned from teaching cybersecurity courses during COVID-19," Proc. Ann. Conf. Information Technology Education, 6 pages, 2020. doi: 10.1145/3368308.3415394

3 Chhetri, C., " "I lost track of things": Student experiences of remote learning in the COVID-19 pandemic," Proc. Ann. Conf. Information Technology Education, 6 pages, 2020. doi: 10.1145/3368308.3415413

4 Vielma, K., Brey, E.M., "Using evaluative data to assess virtual learning experiences for students during COVID-19," Biomedical Eng. Educ., 2020. doi: 10.1007/s43683-020-00027-8

5 Gelles, L.A., Lord, S.M. Hoople, G.D., Chen, D.A., Alejandro Mejia, J., "Compassionate flexibility and self-discipline: Student adaptation to emergency remote teaching in an integrated engineering energy course during COVID-19," Educ. Sci., vol. 10, no. 11, pp. 304, 2020. doi: 10.3390/educsci10110304

6 Ramo, N.L., Lin, M., Hald, E.S., Huang-Saad, A., "Synchronous vs. asynchronous vs. blended remote delivery of introduction to biomechanics course," Biomedical Eng. Educ., 2020. doi: 10.1007/s43683-020-00009-w

Todd Freeborn

Todd Freeborn is an Assistant Professor in Electrical and Computer Engineering (ECE). He regularly teaches courses in circuit analysis, circuit networks, and microcomputers. He is the coordinator for an NSF S-STEM program to prepare students for gateway courses across different disciplines of engineering to support and retain students in these disciplines. Through NSF funding, he has also coordinated REU Sites for engineering students to explore renewable resources and speech pathology.