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Impact of COVID-19 Pandemic on Instructor Course Preparation Time During Transition to Asynchronous and Flipped-Style Lectures: A Case Study

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Introduction

The COVID-19 pandemic impacted students, instructors, and institutions of higher education as everyone had to adapt to lock-downs and abrupt transitions to virtual learning. Research on the effects of this transition have explored the experiences of academics [1], student strategies [2], and academic stress and emotional well-being of students [3]; providing a few but not an exhaustive set of examples. Focusing on the transition to virtual-learning, instructors were required to redesign course content, alter evaluation strategies, integrate new technologies into their workflow, and adapt to students changing needs. Each of these requirements is expected to have increased the course preparation and delivery time commit by instructors to their courses (in comparison to its delivery in face-to-face format). As noted in research regarding teaching time investment, Van de Vord and Pogue reported from their literature review that faculty perceive more time is required with all aspects of teaching an online course [4]. Though in their evaluation of time commitment from both virtual and face-to-face instruction, Van de Vord and Pogue reported that interaction time with students is greater in the face-to-face course while evaluating students and their work is greater in the online courses [4]. This could suggest that teaching online was more difficult which could account for faculty perceptions of requiring more time than face-to-face. In another study, Worley and Tesdell compared instructor time and effort to teach face-to-face and online iterations of two technical communications courses [5], noting the online formats required more time per student when all course activities were pooled. But Worley and Tesdell note that further research is needed to understand how the course structure, maturity of course, instructor attitude, experience and perceptions impact course time and effort. While these studies provide significant insight into faculty perceptions and case studies of effort, they were not conducted in the context of a global pandemic which required an abrupt shift in format and its sustained impact on course delivery. As the impacts of the COVID-19 pandemic are assessed, one site of investigation is how transitions to virtual learning (and sustaining virtual learning) impacted instructor time and effort. This lessons learned paper provides a case study of the alterations in course preparation time for shifting delivery formats to asynchronous and flipped-style delivery as a result of the COVID-19 pandemic for a single instructor across two courses in electrical engineering.

Background

This case study analyses the time committed by a single instructor to two core electrical engineering courses at the University of Alabama, one focused on electric networks (ECE 326) and another on microcomputers (ECE 383). Prior to 2020, both courses were delivered in a traditional face-to-face lecture format, but both transitioned to asynchronous delivery in 2020 (as a response to the COVID-19 pandemic) and then to a flipped-style delivery in 2021 (as the institution transitioned back to face-to-face instruction). During all delivered semesters, the course instructor recorded their daily time commitment to each course providing a dataset to explore the specific number of hours committed and to which specific course activities. This time-tracking by the instructor provides the opportunity for a retrospective analysis of the

collected data to quantify time commit and identify alterations as a result of course maturity and transitions in delivery style (resulting from the COVID pandemic). Additionally, a similar dataset to another electrical engineering course (ECE 320) offered face-to-face for 5 semesters prior to the pandemic (by the same instructor) is available. This provides an opportunity to establish a baseline trend for the time commitment of this instructor teaching the same course multiple times without redevelopment efforts. This focus on time commitment as a result of course maturity and transitions in delivery style aligns with the recommendation of Worley and Tesdell for future research beyond their efforts [5]. Understanding how course maturity impacts time commitment is useful for faculty to estimate workloads and plan work distribution for balancing teaching, research, and service commitments. Further, understanding how the COVID-19 pandemic impacted course time commitments provides further insight to how faculty workload was impacted during this period. While this case study is not generalizable due to the participation of only a single instructor, the insights should be useful for individual faculty and for further research planning related to this topic. The following sections will outline the electrical engineering courses that the instructor taught, the differences related to format (face-to-face vs. asynchronous vs. flipped-style), the methods for time tracking, and the analysis/discussion of the results.

Electrical Engineering Courses

The electrical engineering courses analyzed for this work were 15-week courses delivered at the University of Alabama; a large, southeastern public university in the United States. Undergraduate students in the department of electrical and computer engineering at this institution are expected to complete these courses in their junior year of study. In terms of structure, all courses had weekly online assignments (approximately 12-14, based on the course) and 3 examinations. One course (ECE 383) also had a laboratory component with students attending and completing 8 laboratories during the semester. Each course was designed by the instructor for a face-to-face delivery with initial syllabi and student learning objectives provided by the department (so these courses were not new courses for the instructor to develop). Details regarding the design and differences between styles of delivery as the courses evolved from face-to-face to asynchronous to flipped style are detailed below:

> *Face-to-Face Format:* For each course, 150 minutes of lectures were delivered each week. To support students during lectures, a digital course notes package was provided that included the majority of course theory and notes but had the detailed solutions to examples removed. The contents of these notes were presented by the instructor to the class during each lecture period. Students were encouraged to print and bring copies to class to collect the missing details and assist in completing examples during small-group work. The detailed notes and examples were developed to support students completing the weekly online assignments and preparation for examinations. Attendance was not required and not tracked by the instructor. Beyond lectures, students had access to instructor support with the course materials at 2 weekly, 1-hour office hours sessions. For ECE 383, students were required to attend weekly 2-hour lab sessions coordinated by the course teaching assistant. During this time, students had access to the teaching assistant for support on completing the lab deliverables and were required to complete a demonstration of the lab prior to leaving.

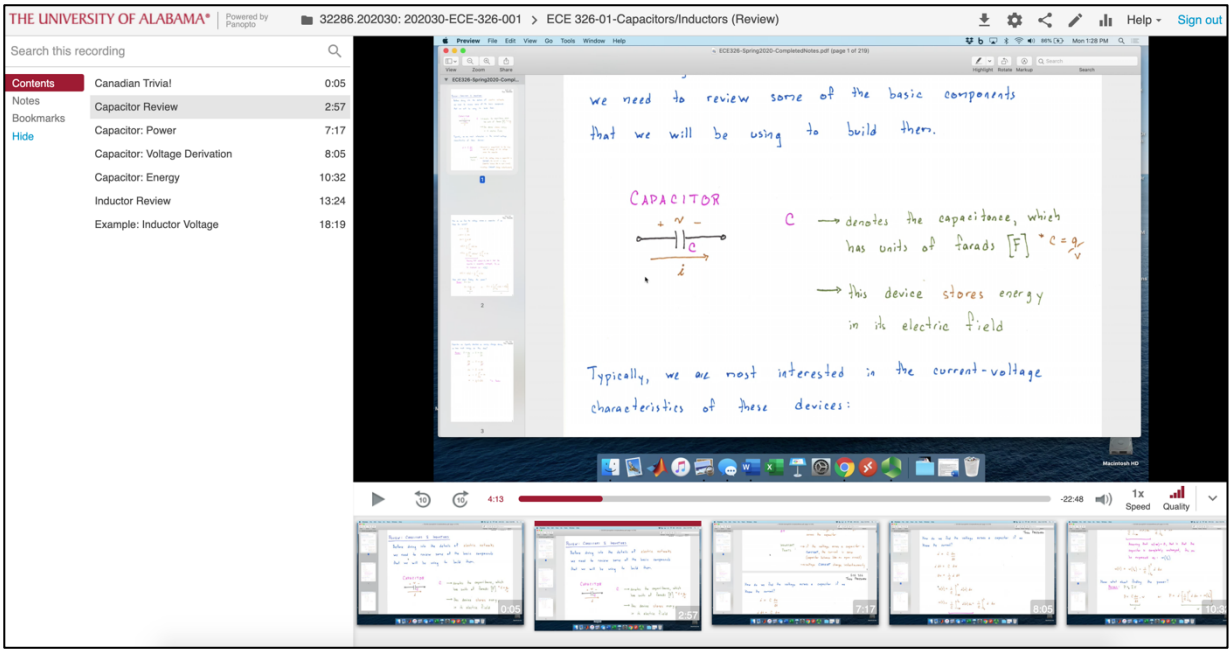

Figure 1: Sample virtual lecture in Panopto system for ECE 326 during Summer 2020 iteration.

Asynchronous Format: For the asynchronous delivery of each course, virtual lectures using were recorded and delivered using the Panopto platform (https://www.panopto.com) that is integrated into the Blackboard Learning Management System (LMS) at the institution. Panopto is a video platform that supports recoding, editing, and managing video content. Additionally, it provides tools for measuring student engagement (such as the number of times a video has been viewed, the minutes delivered during each viewing, and the date/time of the viewing). These lectures covered the exact same material as the face-to-face iterations, with the course notes contents presented by the instructor. 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. The course instructor had prior experience for using Panopto for recording lectures during semesters of face-to-face instruction (to provide lectures when instructor travel prevented in-person delivery), so there was no learning curve with this platform during creation of the asynchronous content.

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 a fixed date/time each week. 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 was done 1-day before the weekly deadline each week to serve as a reminder to students of their current progress an update after the weekly deadline with the final values. Like the face-to-face iterations, students had access to instructor support with the course materials at 2 weekly, 1-hour virtual office hours sessions (using the Zoom video conferencing platform).

For ECE 383, the labs were revised to support remote and virtual participation. Instructions were revised to provide details regarding new materials/equipment for purchase to complete the labs without having to use the physical lab facilities on campus. Additionally, students were provided with access to the physical lab facilities and a supporting teaching assistant but with strict requirements on social distancing and reduced student numbers in the labs. In place of in-person demonstrations, students were required to record and upload a video demonstration to confirm completion of their laboratory activities.

Flipped Format: In the semester after asynchronous delivery, both ECE 383 and ECE 326 were transitioned to a flipped-style class model based on the courses at the institution returning to on-campus, face-to-face delivery. In this style of offering, all course lectures were provided asynchronously using the previously recorded materials with scheduled lecture periods used as work periods to support students in completing the course assignments and/or labs. For the flipped style students were given the option to **i)** watch lecture content prior to scheduled course times and use in-class time for instructor support on assignments/labs, **ii)** attend the scheduled course times and watch the video lectures (with option to ask questions of the instructor), or **iii)** watch the lecture content on their own time and attend lectures only when they had further questions. The intent was to provide students the flexibility to engage with the course in the style that best met

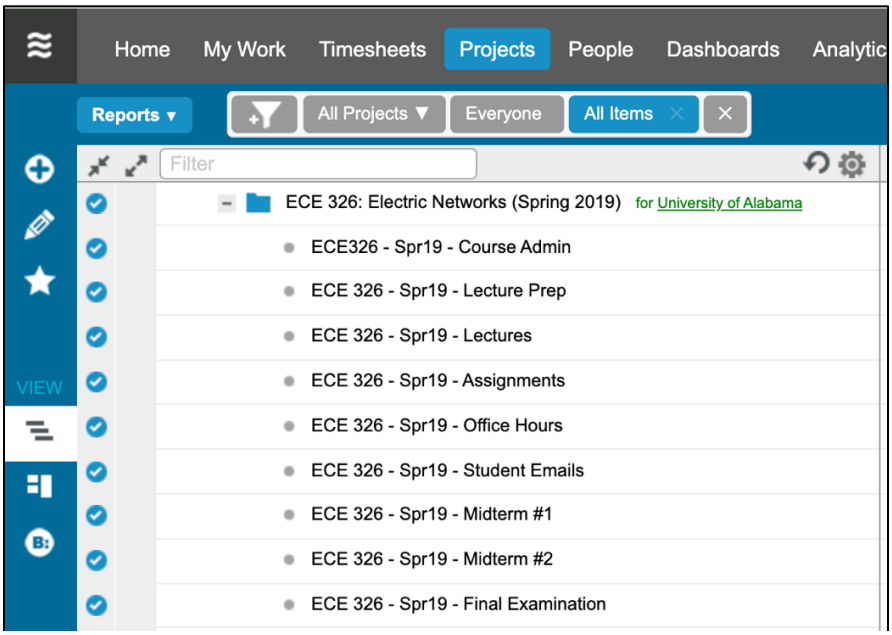

Figure 2: LiquidPlanner project management tool used for recording of time committed to different aspects of a Spring 2019 course.

their needs during a semester still impacted by the pandemic. Like the asynchronous iterations, students had access to instructor support with the course materials at 2 weekly, 1-hour virtual office hours sessions (again using Zoom).

Instructor Reporting of Course Time Commitments

The hours committed by the instructor for each of the analyzed courses in this study was logged using the LiquidPlanner platform (www.liquidplanner.com). This is a web-based project management tool with features for project scheduling, project prioritization, and resource time management. Using LiquidPlanner, each course taught by the participating instructor was setup as a project with individual tasks associated for course elements including administration, lecture preparation, lecture delivery, assignments, student support (office hours/emails), and examination or projects. A sample of this setup for a course delivered in the Spring 2019 semester is shown in Fig. 2. Over the period of study (Fall 2015 to Fall 2021), the participating instructor reported their daily estimated time to each task (rounded to the nearest 15 minutes or 0.25 hours) retrospectively every 1-2 days. The total time (in hours) logged against each of the specific tasks in LiquidPlanner for ECE 320, ECE 383, and ECE 326 across the period from Fall 2015 to Fall 2021 are presented in Tables 1, 2, and 3, respectively. Additionally, these tables detail the total time (in hours) per course semester, the percent difference in total time of a semester in comparison to the first semester of delivery, and the total enrolled students in the course.

Table 1: Instructor Distribution of Time Commitment to ECE 320 activities from Fall 2015 to Fall 2017

	Fall 2015	**Spring 2016**	**Fall 2016**	**Spring 2017**	**Fall 2017**
ECE 320 Course Activity	**Time Commit Per Semester (Hours)**				
Administrative	42.25	39.5	23.75	18.50	20.00
Lecture Preparation	93.25	29.25	9.00	17.25	10.25
Lectures	49.25	40.00	41.25	41.00	43.00
Assignments	40.25	33.50	19.00	13.00	10.75
Exams	64.75	52.50	59.50	43.25	56.00
Student Support	52.00	58.75	41.25	48.75	47.50
Total	**341.75**	**253.50**	**193.75**	**181.75**	**187.5**
Total Difference (%)		**-25.8%**	**-43.3%**	**-46.8%**	**-45.1%**
Course Details					
Total Students	107	82	92	86	108

Table 2: Instructor Distribution of Time Commitment to ECE 383 activities from Spring 2018 to Fall 2021

	Spring 2018	Fall 2018	Fall 2019	Fall 2020 (Asynchronous)	Fall 2021 (Flipped)
ECE 383 Course Activity	**Time Commit Per Semester (Hours)**				
Administrative	19.75	33.00	12.50	57.25	21.25
Lecture Preparation	108.00	18.25	17.50	61.75	19.00
Lectures	39.00	59.50	40.00		36.00
Labs / Assignments	41.50	33.00	20.75	19.25	4.25
Exams	44.25	37.75	52.25	72.00	59.00
Student Support	41.00	26.00	24.00	42.25	17.75
Total	**293.50**	**207.5**	**167.00**	**252.5**	**127.25**
Total Difference (%)		**-29.3%**	**-43.1%**	**-14.0%**	**-56.6%**
Course Details					
Total Students	60	60	80	82	81

Table 3: Instructor Distribution of Time Commitment to ECE 326 activities from Spring 2019 to Spring 2021

	Spring 2019	Spring 2020 (COVID)	Summer 2020 (Asynchronous)	Spring 2021 (Flipped)
ECE 326 Course Activity	**Time Commit Per Semester (Hours)**			
Administrative	15.50	19.50	22.75	40.75
Lecture Preparation	110.00	22.25	28.00	3.25
Lectures	44.75	35.75		45.25
Assignments	44.50	29.25	17.00	12.50
Exams / Projects	64.0	68.25	70	77.25
Student Support	46.75	33.75	36.25	26.00
Total	**325.50**	**208.75**	**174**	**205**
Total Difference (%)		**-35.9%**	**-46.5%**	**-37.0%**
Course Details				
Total Students	90	95	44	111

Analysis

Baseline Trend of Face-to-Face Time Commitment: To establish a baseline trend of time commitment to a single course delivered multiple times (by the same instructor), the data from ECE 320 (in Table 1) is analyzed. This course was delivered for 5 semesters and over this period the total time commit declined from 341.75 hours to 187.5 hours (a decrease of 45.1%). This course was delivered entirely face-to-face for these semesters. Reviewing the individual course activities in Table 1, the overall decrease in hours is attributed to decreases in lecture preparation and assignments hours. As noted previously, lecture preparation for the first iteration of each course required the instructor to develop their comprehensive lecture materials, supporting notes package, and online assignments. After development, these packages were re-

used with minor revision and updating each subsequent semester. In terms of trends, the decreases in time commitment (compared to the first iteration) are relatively stable for the 3rd, 4th, and 5th iterations of the course. The decreases for these iterations range from 43% to 47%. This suggests that after two iterations to develop and revise the course future iterations require similar time commitments for delivery and maintenance. Therefore, the range across iterations 3-5 represent the approximate time that should be allocated per semester for future workload planning when this course is delivered (by this instructor). This highlights the changes in time commitment that occur as a course matures (barring any significant revisions).

Further support for this trend (minimum delivery/maintenance time for a course established by the 3rd iteration) is observed in the time commitment data for ECE 383 given in Table 2. This course was offered for 3 semesters as a face-to-face, lecture format with similar decreases in time commitment after the first iteration. Specifically, a decrease of 43.1% is reported comparing the first and third iterations in Table 2. Like ECE 320, this decrease is the result of decreases in lecture preparation and assignments activities.

Effect of Transition to Asynchronous Delivery on Time Commitment: Based on the trends of ECE 320 and ECE 383 from Spring 2018 to Fall 2019, it is expected that delivery of ECE 383 in the same face-to-face format would require approximately 167 hours for the Fall 2020 semester (a decrease of 43% compared to the first iteration). However, the Fall 2020 iteration transitioned to asynchronous delivery with only a decrease of 14% (compared to the first iteration). This highlights that the transition to asynchronous format required a significant increase in hours commit to the course by the instructor, similar in magnitude to the time required to develop the initial course. In terms of instructor workload, this required 85.5 additional hours of effort for the asynchronous transition. On review of hours distributed across course activity in Table 2, the efforts for course administration, examinations, and student support were the sources of greatest effort increases. The significant increase in course administration hours is attributed to revising course laboratories (requiring 25 hours during the week prior to course launch), attendance grading linked to watching course videos, and academic misconduct activity. Increases in examination hours are attributed to the effort to develop multiple versions of the examination (not previously done for face-to-face iterations) and increases in student support attributed to higher numbers of e-mails and greater office hour attendance for clarifications on course material, assignments, and laboratories. This aligns with the reports of Van de Vord and Pogue that evaluating students and their work is greater in online courses [4].

While ECE 326 does show decreases in time commitment after the first iteration (ranging from 35.9% to 46.5%), the trend is not the same as ECE 320 and ECE 383. This is attributed to 1) ECE 326 being disrupted in its second iteration by the COVID-19 pandemic during the Spring 2020 semester and 2) not having a laboratory component of the course. As noted previously, the most significant increase in the transition to asynchronous delivery for ECE 383 resulted from course administration and laboratory redesign to formats that could be supported virtually. Without laboratory activities, ECE 383 did not have the same increase in workload. Additionally, the transition to asynchronous lecture styles in Summer 2020 was supported by the rapid transition to asynchronous lectures during Spring 2020 caused by the COVID-19 pandemic closure of campus. The lecture content recorded during that period was used during the summer,

requiring fewer additional recordings to launch the course (compared to the asynchronous transition of ECE 383 in Fall 2020 which required all lecture content to be recorded that semester). A significant observation to note is that the asynchronous iteration in Summer 2020 had only 44 students compared to the 90, 95, and 111 of other iterations. However, even with less than half the students of other iterations the total time required for projects/examinations remained the same, highlighting that a much greater amount of work was required to both develop and grade assessments in the asynchronous format. Again, this aligns with the reports of Van de Vord and Pogue that evaluating students and their work is greater in the online courses [4].

Effect of Transition to Flipped Delivery on Time Commitment: For both ECE 383 and ECE 326, the transition to flipped delivery reduced the time commitment by 56.6% and 37%, respectively, compared to the first iteration of each course. While the flipped delivery does not reduce the total lecture time, examination time, or admin time, it is interesting that the student support hours decreased for this format compared to face-to-face and asynchronous modes. Consider ECE 383 which had student support of 24 hours (3rd iteration of face-to-face), 42.25 hours (asynchronous), and 17.75 hours (flipped) across the Fall 2019 to Fall 2021 semesters. The decreases are attributed to the students having greater access to the instructor during flipped class sessions, reducing the need for students to follow-up by e-mail or attendance at office hours. This is significant for both students and the instructor, with students obtaining higher levels of personalized instruction at their point of need and reducing out-of-class activity by the instructor.

Summary of Time Commitments: It is clear from the analysis of the course hours for ECE 383, 326, and 320 that the maturing of a course (in terms of its delivery multiple times by the same instructor) reduced the time commitment of the instructor. Specifically, reductions of approximately 40% were observed by the 3rd iteration in all courses taught by the instructor analyzed in this work. This supports that faculty workload can potentially be reduced by scheduling them to teach the same course in multiple semesters, reducing the amount of time required for course preparation. While not unexpected, the reduction of 40% does quantify the potential time that faculty can gain through this personnel management strategy.

Of importance to understanding the impact of the COVID-19 pandemic on faculty workload, the time commitments to courses transitioning to asynchronous formats were similar to the number required for the initial course design (when that course had a required laboratory component). Therefore, the transition to asynchronous delivery eliminated the time/effort reductions gained through delivering a course multiple times. This is important to understand for faculty interested in moving their classes to this format and their workload planning for a semester. The transition to flipped-style delivery resulted in time commitments similar to face-to-face iterations after the 3rd iteration, but with fewer hours required for student support compared to other iterations. This supports that while this format may not significantly reduce the time of the instructor, it is potentially improving the access of students to the instructor for personalized support with their mastery of course material.

Limitations and Opportunities for Future Work: A clear limitation of this work is that the time commitment data analyzed is from only a single instructor at one institution. This does

offer preliminary insights into trends in course time commitments but requires design of studies to collect data across multiple instructors, institutions, and disciplines to determine if these trends are consistent (or limited to this instructor and the electrical engineering courses taught). Additionally, the transition of delivery format for the courses from face-to-face to asynchronous to flipped without multiple asynchronous iterations prevents exploring if significant time reductions in instructor effort result after the initial redesign to this format. Finally, this study only explores the impact of these delivery formats on the course instructor time commitments. Further study should explore student performance and student perceptions of these specific courses to understand how these changes in delivery style impacted students.

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