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Challenges and Successes in Synchronous Cohort-Based International Education

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Abstract

To increase enrollment, universities have expanded their offerings to international graduate students beyond residential studies. Advances in teaching and learning technology have played a key role in enabling remote instruction to these students. In particular, synchronous instruction and engagement with peers within a cohort have been shown to improve the educational experience and lead to high persistence rates.

It has previously been reported that instructional technology can be used to teach a full master's degree program in electrical and computer engineering to international graduate students in a synchronous fashion. To increase engagement, students study in the program as cohorts and collaborate in the classroom and in completing a significant engineering project. This technology platform allows a single instructor to teach live to multiple classrooms (before COVID-19) and a large number of students at home (during COVID-19). This technology facilitates in-class assessment, proctored examinations, and project-based collaboration.

In this paper, we address some of the challenges in this domain based on our experience of teaching in this modality for over 10 semesters. We review how we have performed in-class assessments, conducted remote exams for student cohorts, and implemented group-based design project courses. We discuss our use of technology to support our educational objectives while overcoming limitations. We believe that our experiences are valuable to other instructors and institutions as they shift toward remote instruction due to ongoing public health concerns related to COVID-19 and a broader need to provide alternative modes of graduate instruction.

1 Introduction

International graduate students remain an important recruitment target for many universities. However, recent geopolitical trends and the COVID-19 pandemic have created substantial challenges for students who wish to matriculate outside of their native countries [1, 2]. Although asynchronous course offerings can be an effective alternative, these programs often lack the interaction with faculty and peers that many students desire. As a result, these programs are often marked by low persistence [3, 4].

Previous work has described an instructional approach that provides high-quality distance education for students who remain in their home country [5, 6]. Instructors teach synchronously to students located in classrooms and at home in countries around the world. This learning environment allows for significant synchronous interaction with instructors and other students, leading to the formation of student cohorts. Prior work indicates that this learning environment is scalable and leads to high program persistence [5].

This synchronous, cohort-based learning environment still presents several challenges. The program curriculum includes a two-semester engineering project that requires close student collaboration, faculty-student advising, and synchronous assessment. In this paper, we describe our novel approaches to facilitating student and faculty interaction and project assessment for a project course. The remote nature of our instructional program also creates a challenging environment for in-class assessment. We detail our novel techniques for evaluating student understanding during lectures and assessing their performance during remote examinations.

Specifically, we address the following question:

- In-class engagement and assessment: How can we engage remote students during synchronous instruction? How can we perform formative assessments during class time?
- Remote synchronous examinations: How can we perform remote examinations to ensure reliable summative assessment?
- Project course collaboration and assessment: How can remote students engage with each other to work on projects? How can learning be assessed in these remote project courses?

We present data on student persistence and program completion, as well as a comparison to the residential program to show the effectiveness of our approach.

The remainder of the paper is structured as follows. We briefly present relevant details of the program for which we have developed this new instructional technology and its impact on assessments (Section 2). We then describe our assessment approaches for in-class evaluation of student progress (Section 3). Novel aspects of remote, synchronous examinations are described (Section 4). We discuss synchronous collaboration and assessment components of the project course (Section 5). We also present program-level outcomes (Section 6). Finally, we summarize our work.

2 Program Overview

The program that we describe here is an M.S. in Electrical and Computer Engineering (ECE) at the University of Massachusetts Amherst, which involves synchronous remote instruction. The synchronicity of instruction ensures that students can engage easily with the instructor and with their peers. An important aspect of this instructional modality is that students study as cohorts and therefore have the ability to engage at different levels than in an asynchronous program.

Instruction takes place via a purpose-built technology package where students and faculty can see and hear each other and also collaborate on shared instructional content. This program has been offered in two modalities: In the "live-to-classroom" modality, students learned together in a physical classroom, where the instructor joined remotely; in the "live-to-device" modality, students learned together by joining a virtual classroom remotely from their own device. Due to the COVID-19 pandemic, our program has shifted to the latter modality exclusively since Spring 2020.

Students can choose to take the entire M.S. degree program remotely or to start the program remotely and then study the second half in-person in the residential program on our campus. The latter "1+1 option" is particularly appealing to our students since it strikes a balance between the lower cost of the remote program (due to lower cost of living compared and the opportunity to take courses part-time while continuing working full-time) and the more engaging experience of studying on campus (see Section 6).

A key aspect of this program is that the educational experience is designed to be as similar as possible to the residential program. The course credits and degrees earned in this program are the same as in the residential program. Therefore, it is critical that we can ensure the same instructional quality and academic rigor as in the residential program. The following discusses our efforts to ensure that we can conduct suitable formative and summative assessments of students' learning and offer opportunities for collaboration in project-based courses.

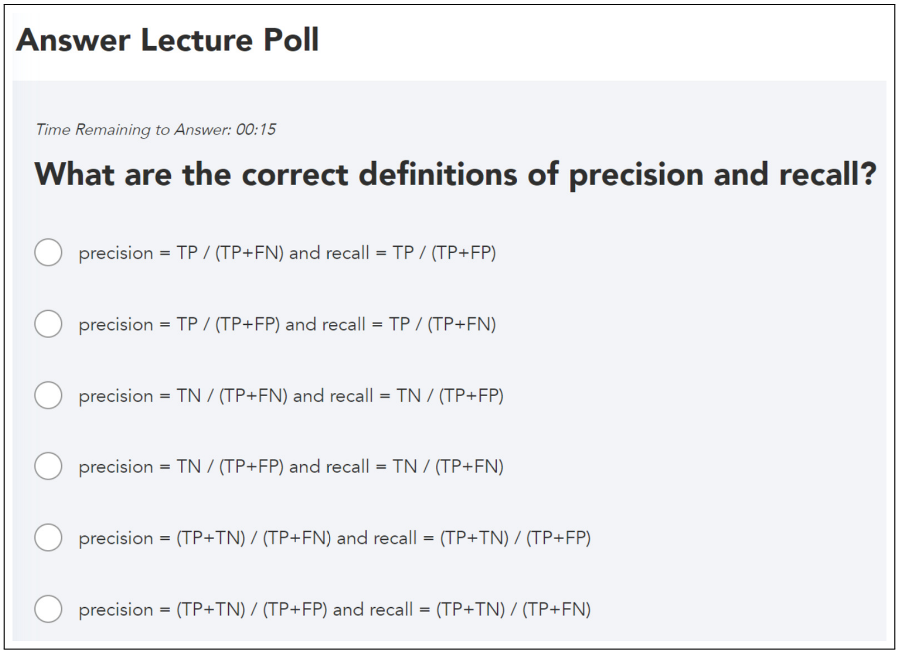
3 In-Class Engagement and Assessment

A distinctive aspect of our program is the use of real-time, in-class assessment. Students actively participate in live assessments during lectures, although they are not graded for these activities. Poll questions, orchestrated discussions (hand raise questions), and group discussions (short answer questions) are examples of these types of assessments. These questions and discussions provide feedback on the students' understanding of important lecture topics and trigger critical thinking by the students.

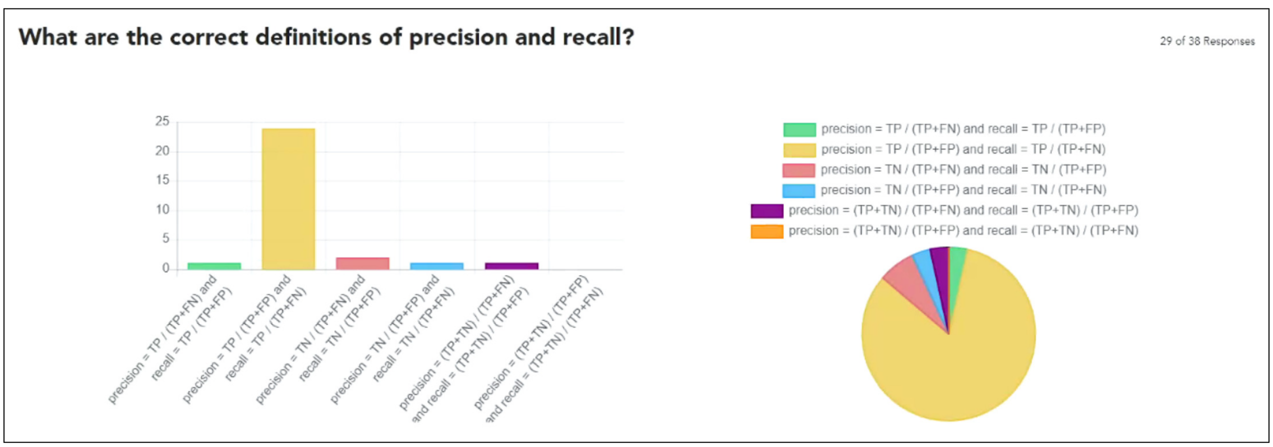
For example, a poll question can check student understanding of a critical lecture topic that the students must know to comprehend the remainder of the lecture material. The format of poll questions displayed to the class during a lecture is shown in Figure 1(a). Students respond to an interactive poll in real time using a learning management system (LMS) interface on their computer. The instructor and the students receive poll results immediately after the poll closes, as shown in Figure 1(b). The instructor may choose to continue the normal pace of the lecture if the poll results look satisfactory or revisit the topic of the poll question if results are unsatisfactory.

An orchestrated discussion (hand raise) activity also tests the students' understanding of a recently discussed topic. In response to a question displayed to the class, a student provides a response using their computer consisting of a few words or a short sentence. This format provides students opportunities to provide direct feedback to the instructor about the lecture material that contains more information than a poll response. In a group discussion activity, students work in small groups of three or four to respond to a question posed to the class. After discussion, one student enters a group response including a few sentences into a computer. All responses are shared with all student groups and the instructor. All students are expected to take part in these discussions and help in creating a group response.

Responses for polls, orchestrated discussions, and group discussions are saved and can be reviewed by the instructor after lecture for deeper insight into the lecture's effectiveness. Synchronicity of instruction is key to these formative assessments since it allows instructors to adapt to students' learning in real time.



(a) Poll question presented to students during lecture. Each student uses an LMS interface on their computer to make their selection.



(b) Poll results display for the poll shown above.

Figure 1: Poll question and results.

4 Remote Synchronous Examinations

Proctored, synchronous examinations form a significant portion of a student's final grade for many courses in our synchronous remote M.S. program. These examinations are challenging to conduct in a remote environment.

If students can be co-located, synchronous examinations for the program can be held in large conference halls with local proctors and remote monitoring of the examination hall by the course instructor(s) and teaching assistants. Live video feeds from the four corners of the examination hall are provided to the course instructor(s) to monitor the test-takers in real time. Test questions can either be distributed via the course LMS on student laptops or in paper test books printed by

Figure 2: An example of a remote synchronous examination with co-located students. Proctoring is performed both locally by program staff and remotely via webcam by the course instructor and teaching assistants.

local proctors. The risk of student misconduct during the test and/or use of improper resources (through their computers) is low due to the presence of the local proctors and live camera feeds. An example of a remote, proctored examination is shown in Figure 2.

As our program expanded to include students that cannot easily co-locate and due to the effects of the COVID-19 pandemic, the use of centralized testing facilities became impractical. As a result, we employed remotely-proctored testing mechanisms that have become widely-used in the United States and elsewhere. These approaches include:

- A commercial test-taking software package that takes control of the test-taker's computer for the duration of the examination. The software blocks or limits Internet access and records on-screen activities along with the video camera feed.
- A commercial test-taking software package that limits student Internet access but otherwise allows full computer use, including the potential use of inter-student chat programs. The test-takers run live video sessions to provide the proctors with a view of themselves while taking the test. The limiting nature of this software has led some test-takers to express concerns about the security of their computer when not taking a exam.
- Synchronous open-book tests. In this exam format, student Internet access is not limited. Students provide a live feed of their activity to remote proctors using a computer webcam.

The live feeds are recorded for post-exam analysis, if required.

These approaches provide a range of synchronous, summative assessment options with tradeoffs between less risk of student misconduct and less intrusion on students' computers or personal spaces [7].

5 Project-Based Course Collaboration and Assessment

An important aspect of our synchronous, remote M.S. degree program is a team-based project course that spans two semesters. The course provides students the opportunity to select an engineering project topic, develop a design, implement a prototype, and demonstrate a finished product. Students form two- or three-person teams at the start of the course. The first semester involves project topic selection, preliminary system design, and prototyping. The second semester involves project integration, testing, and final packaging. The development of professional presentation and technical writing skills are important aspects of the course.

5.1 Student Instruction and Advising

The synchronous, cohort-based nature of our program provides several unique opportunities for project instruction, collaboration, and assessment. All students enrolled in the project course attend synchronous lectures. Over the two semesters, lectures covering topics such as project definition, how to give a presentation, how to prepare a technical document, and data analysis are presented. Each student team is advised by the course instructor and team progress is assessed during weekly video conferences in which students describe implementation challenges, discuss design and implementation progress, and perform brief demonstrations. All students are expected to participate in the advising sessions. Students may be co-located or in different locations. In several cases, teams with both international students in their native countries and domestic students collaborated together to complete a single project.

5.2 Design Reviews

Four synchronous one-hour assessments (evaluations) performed by faculty evaluators over the duration of the project form the primary assessment mechanism for the course. The faculty evaluators' only role in the course is to assess the projects. They do not supervise student teams nor serve as course instructors. Their role is to provide independent assessments of the project topic and students' progress throughout the course.

During these evaluations, each student team gives a synchronous presentation and project demonstration using interactive teleconferencing technology. Students may be co-located in a classroom or in separate locations interconnected via videoconferencing. Faculty evaluators are located at a remote location and communicate via videoconferencing. During the first thirty minutes of an evaluation, students jointly present their work uninterrupted. During the subsequent twenty minutes, faculty evaluators ask the students questions and they are given opportunities to respond. The final ten minutes are reserved for private faculty evaluator discussion and graded team assessment.

During the first semester of the project course, preliminary design and prototype design evaluations are performed. The preliminary design evaluation provides students feedback on the planned work and the project goals early in the semester. The prototype design evaluation, which comes at the end of the first semester, provides an opportunity for students to describe how they overcame challenges in developing pieces of a hardware prototype and demonstrate progress to date. During the second semester, a comprehensive design evaluation gives students an opportunity to demonstrate a functioning, but often unpolished, system to evaluators. The final project evaluation provides a final opportunity for faculty assessment of the completed project.

5.3 Project Course Challenges

The implementation of the project course using a synchronous remote platform presented challenges both for students that could co-locate in a physical classroom and for students that could not interact in-person. In some cases, a team included a mix of students in both categories. Project collaboration and assessment challenges, and our approaches to address them, include:

- Distributed project development: Most design projects require the integration of hardware and software components to build a complete system. The physical distribution of team members makes hardware integration difficult. As a result, co-located students were often tasked with hardware development and integration and isolated students developed software. In many cases, project software could be accessed via the Internet (e.g., via the cloud).
- Remote project evaluation: Since faculty evaluators were unable to physically examine project design components, additional cameras and video streams of the demonstrations were needed. Multiple perspectives of the demonstrations were often provided to allow for full performance evaluation. Students in distributed locations typically required extra practice to successfully coordinate the presentations and demonstrations.
- Student collaboration: Student teams often included team members on different continents and in different time zones. Students were encouraged to frequently interact via text message and email in addition to live videoconference to help bridge the time difference gap.
- Project component purchasing: Each team was allocated $500 US to purchase project components. Program staff made the requested purchases and had the items shipped to students.

As mentioned in Section 2, we designed this synchronous cohort-based degree program to be as similar as possible to the residential program. The ability to conduct project-based courses and formative and summative assessment greatly helps in creating comparable experiences for students and instructors. We see the results of these efforts in the program-level outcomes, which we discuss next.

6 Program-Level Outcomes

The synchronous remote M.S. in ECE program described in this paper has been offered continuously since Fall 2017. The program offers courses during three semesters per year (Fall, Spring, Summer) and thus is currently in its 11^{th} semester.

Table 1 summarizes the number of program participants. A total of 178 students have participated in this program. Of these students, 39 students have completed the degree program, 133 students are still active, and 6 students have dropped out. Note that the COVID-19 pandemic has created

Table 1: Student Outcomes in Entire Program

Student Status	Individuals
Completed with M.S. degree	39
Active	133
Dropped out	6
Total	178

Table 2: Student Outcomes for Cohorts that Started between Fall 2017 and Spring 2019

Student Status	Individuals
Completed with M.S. degree	39
Active	4
Dropped out	4
Total	47

significant disruptions for students who intended to pursue the 1+1 option. It is possible that students who are still listed as active may not continue in the program due to a variety of issues. With the current data, out of 178 students who have started the program, 172 have finished or are still active, which corresponds to a rate of 96.6%.

This retention rate of 96.6%, which we have been able to sustain over a full degree program, is vastly higher than what it typically observed in online courses. As comparison, it has been reported that "40% to 80% online students drop out of online classes" [4]. We attribute our higher retention rate to the synchronous and carefully structured engagement of students.

An alternative look at the data considers only those cohorts that could have reasonably completed their degree programs by now. Table 2 shows the data for students in cohorts between Fall 2017 and Spring 2019. Of the four active students, three have switched from the course-option M.S. degree program to the thesis M.S. degree program, which typically takes longer. The four students that dropped out left the program due to very low grades, which made it practically impossible to complete the degree program. Of the 39 students who have completed the M.S. degree, 29 students studied in the 1+1 option and 10 students studied entirely remotely.

Figure 3 shows a histogram of the number of semesters taken by students who have completed the synchronous, remote degree program. Note that due to scheduling, some students have semesters in which they take no classes (e.g., summer semesters in the residential portion of the 1+1 option). Only semesters in which students were active (i.e., took at least one course for credit) are considered in the data shown in the figure. The one student who completed the program in 3 semesters took an unusually high course load of 16 credits in the final semester and is, therefore, an outlier. Most students take 4 semesters, which corresponds to the time that is planned for normal progression through the program. The students who took longer either spread their workload over more semesters or had to re-take some courses to increase their GPA.

An important question that has arisen in different contexts is related to the academic rigor of the program. Specifically, is the academic rigor of the remote instruction program indeed comparable to what is offered in the residential program? A direct comparison is difficult, but Figure 4 shows

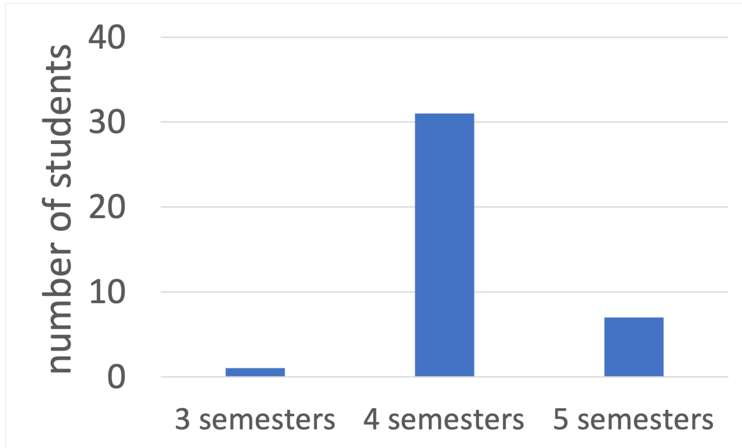


Figure 3: Number of semesters of active study taken by the 39 students who have completed M.S. degree in the synchronous, remote program.

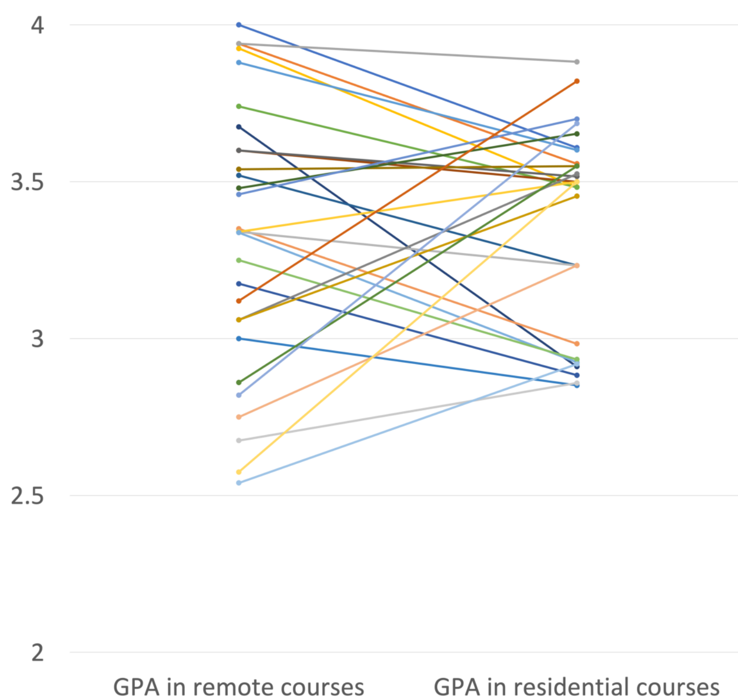


Figure 4: Comparison of GPA in courses taken remotely vs. on campus for students in the 1+1 option who have completed their degree.

data that relates the GPA achieved in remote courses with the GPA achieved in on-campus courses by those students who are in the 1+1 program (and thus take courses in both formats) and who have completed their degree. Each line corresponds to one student. As can be observed, there are students who do less well on campus (i.e., downward-pointing line), but there are also students who do better on campus (i.e., upward-pointing line). Specifically, there are 16 students who had a better GPA in remote courses and 13 students who had a better GPA on campus. Four students improved by 0.5 grade points or more in on-campus courses whereas only one student performed less well by 0.5 grade points or more. These data suggest that students who take remote courses can perform just as well, or better, when taking regular on-campus courses. Thus, there is no indication that our remote instruction is of lower academic rigor compared to on-campus courses.

Overall, these data show that students can learn, perform well in assessments, and complete our degree program that is offered via synchronous cohort-based instruction.

7 Summary and Conclusions

This paper describes how we engage and assess students in our synchronous cohort-based M.S. in ECE degree program. We describe how we increase engagement and conduct formative assessments in the classroom. We also discuss our methods for synchronous summative assessments. Our approach to enabling peer interactions and collaboration on a project-based course is also described. Our program-level data show that 96.6% of students who start the program have either completed it or are still active in the program. Our comparison of course GPAs shows that students on average perform equally well in remote courses as in on-campus courses, thus indicating that our approach to remote instruction is effective and of comparable academic rigor as on-campus instruction. Thus, we believe that synchronous cohort-based instruction is an effective and practical approach to expanding the reach of graduate degree programs in engineering.

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