Toward Understanding Impacts of E-Campus Course Synchronicity on STEM Learners

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Abstract
While the asynchronous nature of online education is typically considered a key advantage due to the inherent flexibility it provides to students, recent work has begun to challenge this assumption. For example, there is evidence that synchronous interaction in online courses not only encourages students to more fully engage with course activities, but also seems to foster a greater sense of community across learners (and especially so for underrepresented students). Our research aimed to extend this previous work by studying student expectations for and experiences with content synchronicity levels in our large public university's Ecampus courses. To begin to understand current student expectations and experiences, we gathered online survey data and final grade information from students enrolled in Ecampus STEM courses at Oregon State University. Survey results showed that students had little trouble accessing the studied courses. Additionally, responses indicated that students are having success interacting with the provided course materials, but that little or no time is being spent interacting with classmates or the instructor in Ecampus work. Taken together, the results of this work can help to motivate the facilitation of new types of interactions in online courses.

Keywords: Online Education, Student Experience, Multi-Method Research

Motivation and Background

As STEM educational opportunities move increasingly online, it is important to consider how characteristics of this online delivery might help or hurt students. While asynchronous interaction is often the norm for online coursework, recent research has suggested that the incorporation of synchronous interaction can have marked positive effects on learning and cognitive outcomes [10,13]. For example, past work shows that the more synchronously students are able to engage, the more assignments/course components they complete [5]. This is somewhat in contrast with the historical perspective that the inherent flexibility of online and asynchronous learning has the potential to improve access to higher education [2,15]. The potential benefit of synchronous interaction is perhaps not surprising, as one of the main complaints of online learners is that they often feel isolated or frustrated within asynchronous course content and the types of peer interaction it affords [6,16]. Providing a chance to work synchronously with a team can lead to higher levels of satisfaction [10] and engagement [7,20] without necessarily detracting from, nor inhibiting, engagement with other independent asynchronous course content [14]. This insight is promising since higher perceptions of social interaction also tend to increase the likelihood that students will continue to take additional online coursework [21]. Thus, our presented work centers on the idea that synchronous content within online education offers sufficient advantages to merit study in further disciplines and contexts.

But how much synchronous engagement is enough? As synchronous interaction can be difficult to coordinate for both instructors and students, it seems useful to explore the bounds on the need for synchronous interaction. For example, while students seem to have an expectation for some kind

of social interaction in online coursework [12], it is not entirely clear how much synchronous contact is normally anticipated. One might speculate this expectation varies within the online student body, as flexibility (e.g., not having to be in class or to interact at a specific time of the day) is often touted as a major draw of online instruction [2]. However, this assumption of course flexibility as a necessary characteristic of online education has recently been challenged as problematic, and in fact prohibitive of an optimal learning experience [9]. For example, asynchronous learners often feel confused, requiring additional self-evaluation efforts to help mitigate said confusion [1]. The identification of what synchronous elements matter most can help instructors to decide how to allocate their scarce time resources when designing and running online courses, and help students to succeed at learning while avoiding lower-impact synchronous obligations in online coursework.

Further, while online education has the potential to improve access to STEM learning for historically underrepresented groups, previously observed trends indicate that various types of attrition can interfere with this promise. For example, although online learning is broadly embraced as a solution for serving non-traditional students, attrition rates as much as double for online classes compared to similar in-person offerings [3,8]. This drop-off is especially high for online STEM education [18]. Further, outcomes in online education are worse for students with less academic preparation [19], with some work also indicating that outcomes are worse for students of ethnicities underrepresented in STEM [17]. These obstacles to online learning will often be a double- or triple-threat to students from underrepresented backgrounds in STEM, who often possess intersectional identities [4]. Specific aspects of online education can also present simultaneous benefits and drawbacks for underrepresented learners in STEM. For example, the ability to ask questions anonymously and asynchronously offers a respite from certain power and privilege dynamics of the typical STEM classroom, but isolation feelings already experienced by underrepresented learners are also exacerbated by asynchronous online education [11]. This complex combination of challenges highlights the importance of considering whether and how method of content delivery particularly affects underrepresented learners in STEM fields. Our line of research overall aims to tackle the topic of underrepresented student experience in Ecampus classes; to begin, we probe the related foundational ideas of whether Ecampus learners on our campus generally experience access issues while taking classes, as well as how students currently interact with course content.

Taken together, the body of related work led to our interest in two research questions: 1) *what are student expectations and needs related to level of synchronicity of course delivery?* and 2) *how does synchronous online delivery affect (or even inhibit) participation of students in STEM*? We began to address these questions using a broad online survey of students enrolled in Ecampus STEM courses at our large public university (i.e., Oregon State University), aiming to assess existing expectations of (and barriers to) online synchronous instruction. Further, we considered whether and how current Ecampus instruction allows for the three types of interaction typically touted as central to engaged university learning (i.e., interaction with course materials, interaction with the instructor, and interaction with peers). So far, our most salient results seem to relate to types of interaction that are happening or not happening in Ecampus classes; more interaction, perhaps including synchronous interaction, with classmates and course instructors may offer improvement to the current state of the art.

Methods

In this study, we aimed to begin to understand potential barriers to and current expectations of synchronous interaction in Ecampus coursework across a variety of academic content domains. We broadly surveyed students enrolled in Ecampus STEM courses at Oregon State University, using an IRB-approved online survey-based study. The details of this survey follow.

Procedure

Participants were recruited through emails to the instructors of relevant (STEM Ecampus) courses at our large public university. Courses were not required to have explicitly synchronous content; we rather conducted this broad survey and gathered information about synchronous course interactions as part of the study, knowing that most courses have some opportunity for synchronous interaction (e.g., videoconferencing-based office hours or Discord voice channels).

The study survey was self-contained in Qualtrics and collected information about current and past Ecampus enrollment and high-level course experience details. After collecting informed consent, the survey asked about typical methods for accessing elements of Ecampus courses, in addition to opinions on different online learning tools and reports on typical interactions during Ecampus learning. In the final survey portion, participants answered free-response questions about their decision to take Ecampus classes and their online learning experiences, followed by closing demographics questions. Upon completing the survey, respondents could elect to enter a drawing for a $10 Amazon gift card.

Measurement

Survey questions ranged from querying about very straightforward aspects of online learning infrastructure (e.g., access to a computer, availability of high-speed internet) to technologies more directly relevant to synchronous interaction (e.g., experience using Discord or gather.town as educational tools). The survey sections collected the following information.

- *Opening portion:* text entry, multiple-choice, select-all-that-apply questions on:
    - Current Ecampus enrollment
    - Cumulative amount of Ecampus coursework experience
    - Typical devices used to access Ecampus content
    - Past applications, tools, and websites used for Ecampus courses
- *Middle portion:* Likert-type, multiple-choice, select-all-that-apply, slider questions on:
    - Physical location, internet browser, and network type from which students typically access Ecampus course content, as well as satisfaction with these different facets
    - Camera and microphone information
    - Frequency of use of, access to, and quality of the devices used for Ecampus work
    - Comfort of use and value of use for Ecampus course applications, tools, and websites
    - Levels of asynchronous and synchronous interaction with peers and instructors during the course
- *Final portion:* free-response questions on:
    - Reason for enrolling in Ecampus coursework
    - Perceived benefits and drawbacks of Ecampus courses compared to in-person courses

    - Potential points of improvement and additional comments on Ecampus courses
- *Demographics:* questions about age, gender, hometown, nationality, race, first-generation college student status, and veteran status

Following the survey, we contacted the university registrar to obtain Ecampus course final grade information for the participants, as a complementary objective measure of performance to consider alongside the survey data.

Participants

58 participants completed the full survey and were included in the presented analysis. These 26 men, 27 women, three non-binary individuals, and two participants who selected other or chose not to disclose gender, were aged from 18 to 54 years old (M = 30.9, SD = 9.4). Respondents mostly hailed from the United States (50 of the group). 43 participants were White, 13 were Asian, 8 were Latino or Hispanic, 2 were American Indian or Alaskan Native, 1 was Black, and 3 selected Other. (Responses could include multiple racial identities.) 14 participants were first-generation college students, and four participants were veterans of the US Armed Forces. Information on participants' experience levels taking Ecampus courses appears in Table 1.

Table 1: Past Ecampus course experience levels from the study sample.

# Classes	Count
1	6
2-4	16
5-8	12
9+	24

Analysis

For this preliminary analysis, we used mainly categorical response tallies and descriptive statistics to identify portions of the survey with the most potential for follow-up study and hypothesis generation. We also performed a thematic analysis on free-response data to help support these next-steps ideas. A first trained annotator coded the full dataset and a second rater coded 10% of the data. The resulting Cohen's kappa was 0.70, which indicates a substantial level of inter-rater reliability.

Results and Discussion

Overall, the results show little difficulty accessing current course materials, as well as low levels of interaction with peers and the teaching team during Ecampus coursework, as further detailed below. These realities of Ecampus coursework interactions are often in contrast with students' desired learning experience, as further explained in the discussion.

Survey Quantitative Results

As summarized in Table 2, all participants used laptop computers to access Ecampus course materials, and 48 of the 58 participants used their phone for coursework as well. Others also used desktop computers (23 participants) and tablets (14 participants). For content accessed via a web browser, Chrome was the most common browser for engaging with Ecampus course material (37 participants). Next were Firefox (12) and Safari (7), followed by one user for each of Edge and Opera. For the tablet and phone users, Wi-Fi was more common than using phone plan data for

connecting with course materials, but not all respondents used Wi-Fi for course activities performed on their phones. 39 participants used more Wi-Fi than cellular data, six used more data than Wi-Fi, and three used about an equal amount of each. On average, participants found all devices to be reliable (i.e., all mean scores were above "Somewhat agree," or 5 out of 7) other than in the case of one participant, who used an Android tablet.

Table 2: Hardware types used to access Ecampus course materials.

Method	Count
Laptop	58
Phone	48
Desktop	23
Tablet	14

Accessing Ecampus content from home was, perhaps unsurprisingly, the most common location for engaging with course content. Six students frequently worked on Ecampus course material on campus and six from a public location outside of a physical campus. 42 respondents ever (rarely up through very frequently) worked on these course activities in a public location off campus, and 14 participants ever worked on the courses from on campus. Table 3 summarizes these access location results.

Table 3: Physical locations for performing Ecampus work. Counts represent respondents who ever worked on Ecampus courses from each location. Frequent users are also noted.

Location	User Count	Frequent User Count
Home	58	58
Public location off campus	42	6
On a college campus	14	6

Course utility-wise, email was extremely common (used by all participants), as were Canvas discussion boards (used by 53 of the 58 respondents). Additional most common tools were Discord (41 participants), Zoom (39 participants), Gradescope (38 participants), and Slack (10 participants). These results are summarized in Table 4. Students seemed to be comfortable with these course utilities (i.e., mean scores were above "Agree" for all tools listed here).

Table 4: Course utilities used by the surveyed Ecampus students for interacting with the teaching team and classmates during coursework.

Utility	Count
Email	58
Canvas Discussion Board	53
Discord	41
Zoom	39
Gradescope	38
Slack	10

As elucidated in Table 5, 72.4% of participants reported having used videoconferencing in some way for their Ecampus learning. Of this group, everyone had access to a working webcam, as well as a working microphone. Although 31 participants had access to private spaces from which to videoconference, 10 used shared spaces in the home and one used public spaces. Most participants (37) were happy with their internet quality (strongly agreeing or agreeing that it was reliable for video conferencing), but five were not.

Table 5: Information on videoconferencing use, use location, and network quality satisfaction by survey respondents.

Videoconferencing Use?	**Overall Count**	**Primary Use Location (Private/Shared/Public)**	**Network Satisfaction (Yes/No)**
Yes	42	31 / 10 / 1	37 / 5
No	16	-	-

All participants but one had also viewed video lectures from their course instructors as part of their course engagement. Everyone agreed to some extent that the videos played back well (responding with an answer from "Somewhat agree" or 5 to "Strongly agree" or 7).

In terms of time spent in different types of asynchronous and synchronous interaction, respondents spent a mean of 6.0 hrs/wk interacting asynchronously with their peers about course activities (*SD* = 5.6 hrs/wk), plus 1.7 hrs/wk on average working synchronously with peers (*SD* = 3.0 hrs/wk). Further, 4.6 hrs/wk was the mean amount spent interacting asynchronously with instructors (*SD* = 5.9 hrs/wk), and participants spent a mean of 1.4 hrs/wk interacting synchronously with instructors (*SD* = 3.1 hrs/wk). Many students never interacted synchronously with peers during the Ecampus courses (20 of the 58 participants), and most students never interacted synchronously with the teaching team (30 participants). 39 participants overall spent one hour or less interacting synchronously with peers each week, and 45 respondents spent one hour or less interacting synchronously with instructors each week.

Survey Qualitative Results

As might be intuited based on past online learning research, participant reasoning for taking Ecampus classes included the students' current location as the most common theme (31 participants), followed by flexibility (24 participants). Many students (17 participants overall) also had significant obligations outside of school, such as a full-time job or childcare responsibilities, that led them to take Ecampus classes. Cost (10 participants), postbaccalaureate opportunities (7 participants), course offerings and assigned instructors (7 participants), the nature of Ecampus classes (6 participants), health concerns (4 participants), and convenience (3 participants) were the other themes mentioned by more than one participant in the dataset.

When asked about the advantages of Ecampus learning compared to on-campus learning, some of the same responses appeared again, in addition to further topics. From the theme set above, flexibility was an even more common response to this second free-response query (48 participants). Location (16 participants), obligations (8 participants), cost (3 participants), the nature of Ecampus classes (3 participants), and health (2 participants) appeared in responses again as well. New advantages surfaced via this question included the ability to rewind (7 participants),

course discussion boards (5 participants), networking opportunities (3 participants), and alleviation of social anxiety (2 participants).

Almost as common as mentions of flexibility as an advantage were comments on lower interaction levels (with instructors, peers, or both) during Ecampus learning as a key disadvantage compared to on-campus learning (45 participants). Limitations in the course content was another common critique (12 participants), where three participants overall noted that Ecampus classes felt easier to them. Additional cons or limitations mentioned by participants were the cost of classes (3 participants), missing the college experience (3 participants), less feeling of engagement (3 participants), confusion about the course logistics (3 participants), less personal feedback (2 participants), less accommodation for student needs (2 participants), and the occasional stigma of online education (2 participants).

Course Grade Results

In brief, most students seemed to be consistent and successful in their performance across various classes, suggesting that they were able to effectively learn within the provided e-learning frameworks. Some students did not experience success, and future analyses will attempt to better identify whether this disparity in performance is related to their ability to access or engage with the course.

Discussion & Continued Work

Based on our analysis so far, students do not seem to be having trouble accessing the tools typical of Oregon State's Ecampus programs or engaging with the course material. For example, respondents appear to have good internet connections and computer access, despite our university's high cross-section of students from rural communities. Survey results indicate that students are having success interacting with course material, but also that very little or no interaction with their peers or instructor are happening in their Ecampus work. This idea returns as the main disadvantage that participants noted for Ecampus courses; almost all respondents experienced lower interaction levels with classmates and the teaching team during Ecampus coursework, and found this to be a key disadvantage. Despite this gap, student performance in the classes was overall strong.

This work-in-progress paper provides an early look at the results of a broad Ecampus student survey that can help elucidate broad or individualized challenges in this type of schoolwork. Although the sample could be improved through more participants and broader demographics, this first step is helpful for honing methods and generating future hypotheses. Our next steps will include further analysis of the collected data, including a deeper dive into the individual experiences of students who were not ultimately successful in their Ecampus coursework, as well as students in the dataset with identities underrepresented in STEM. Questions of how to move additional types of engineering curricula online, how to support underrepresented students in STEM, and how to provide an engaging learning experience in Ecampus curricula are popular but in-progress areas of engineering education research. The outcomes from our project can help to lay the groundwork for more broad and theoretical investigation into these important but complex pedagogical questions.

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