# Toward Understanding Impacts of Ecampus Course Delivery on Underrepresented 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. 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, especially for underrepresented students. Our research extends this previous work by studying student expectations for — and experiences with — content synchronicity levels in our large public university's Ecampus courses, in addition to assessing student access to computer resources, network connections, and physical spaces that would typically support maximal success. Self-reported online survey data from students enrolled in Ecampus STEM courses included information on access to key resources, time engaging synchronously/asynchronously with peers and instructors each week, and final grades. Survey results showed that 20 of the 58 student participants self-identified as belonging to a race underrepresented in STEM, being a first-generation college student, and/or being a veteran of the US Armed Forces. Students who self-identified as belonging to a minoritized group were more likely to experience access issues and to perform less well academically compared to other surveyed students. A possible explanation for the performance disparity is the tendency of the minoritized group to spend less time interacting synchronously with classmates and instructors. The results of this study may help to motivate the facilitation of new types of accessibility checks and interaction facilitation in online courses.


## Background

As STEM educational opportunities move increasingly online, it is important to consider how students physically access course materials, and further, how inherent characteristics of online coursework (such as more flexibility in how and when to complete course assignments) might interact with access issues, thereby impacting students.

The ability to appropriately access online coursework is unfortunately not consistent for all students. For example, some students may not possess the necessary computing hardware or sufficient internet access to take an online course. As evidenced during the COVID-19 pandemic, many potential learners do not have the necessary computer and network infrastructure to support online learning (Cullinan et al., 2021). This 'digital divide' is especially prevalent in students who are members of groups that are typically underrepresented in college/university settings. For example, individuals that identify as first-generation, low-income, and non-White (FGLINW) often have significantly lower levels of access to technology critical for online learning (Banerjee, 2020). Similarly, students from rural areas often struggle to meet the hardware requirements that are necessary to take online courses (Graves et al., 2021). Thus, it cannot be assumed that all students have equitable access to online learning, and it becomes important to understand what hardware/networking learners might/might not have access to, in order to better design coursework such that access issues are not barriers to participation and learning online. Importantly, any access issues (i.e., very slow internet connection) will likely reverberate throughout the course experience for these affected learners. Accordingly, one focus of our work was assessing the hardware quality, network quality, and physical space characteristics of current Ecampus learners.

Further, while a large amount of 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 (Kuo et al., 2014; Martin et al., 2021). Past work shows that the more synchronously students are able to engage, the more assignments/course components they complete (de la Torre et al., 2013). 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 (Blayone et al., 2017; Parsad et al., 2008). 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 (Dumford & Miller, 2018; Phirangee & Malec, 2017). Providing a chance to work synchronously with a team can lead to higher levels of satisfaction (Kuo et al., 2014) and engagement (Francescucci & Rohani, 2019; Yamagata-Lynch, 2014) without necessarily detracting from, nor inhibiting, engagement with other independent asynchronous course content (Oztok et al., 2013). 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 (Zhu et al., 2020). Such dynamic synchronous interaction (e.g., Zoom or video chatting), however, is heavily dependent on students' computing infrastructure (e.g., computer quality, computer access, network quality). Poor internet quality and outdated videoconferencing hardware, as a few examples, could serve as barriers to students engaging in effective synchronous interactions. Thus, our presented work also centers on the idea that synchronous content within online education merits study in further disciplines and contexts, and that it is important to consider possible access issues when recommending synchronous activities.

Synchronous engagement comes with potential gains, but also characteristic challenges. How much synchronous engagement is enough? For example, while students seem to have an expectation for some kind of social interaction in online coursework (Martin & Bolliger, 2018), it is not entirely clear how much synchronous contact is normally anticipated. One might speculate that 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 appeal of online instruction (Blayone et al., 2017). 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 (Houlden & Veletsianos, 2019). For example, asynchronous learners often feel confused, requiring additional self-evaluation efforts to help mitigate said confusion (Alhazbi & Hasan, 2021). 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 (Boston & Ice, 2011; Hachey et al., 2022; Hachey et al., 2013; Joosten & Cusatis, 2020; Zamecnik et al., 2022). This drop-off is especially high for online STEM education (Wester et al., 2021; Wladis et al., 2014). Further, outcomes in online education are worse for students with less academic preparation (Xu & Jaggars, 2013), with some work also indicating that outcomes are worse for students of ethnicities underrepresented in STEM (Gardner & Leary, 2023; Kahn et al., 2022; Shaikh & Asif, 2022; Wladis et al., 2017). These obstacles to online learning can be a double- or triple-threat to students from underrepresented backgrounds in STEM, who often possess intersectional identities (Cochran et al., 2020). 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 (Humiston et al., 2020). 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 research addresses the topic of underrepresented student experience in Ecampus classes, with an eye on risk factors that may disproportionately influence these students (e.g., access challenges).

Taken together, the body of related work led to our interest in three research questions:

1) What, if any, technology access challenges are currently being experienced by Ecampus students?
2) What practices do students currently follow with respect to amounts of asynchronous and synchronous engagement during Ecampus learning?
3) How does online course delivery influence the learning experiences and outcomes of students from minoritized groups specifically?

We began to address these questions in a previous study using a broad online survey of students enrolled in Ecampus STEM courses at our large public university (i.e., Oregon State University), assessing existing expectations of (and barriers to) online instruction. In alignment with the first two research questions, we considered whether and how current Ecampus instruction allows for the three types of interaction typically touted as central to engaged university learning: 1) interaction with course materials (i.e., via appropriate computer hardware and network connections); 2) interaction with the instructor (e.g., via computing and network resources, as well as spaces from which to synchronously call); and 3) interaction with peers (via similar tools as student-instructor interaction). Results of these initial analyses were presented at the American Society for Engineering Education (ASEE) 2024 Conference (Sanchez et al., 2024). Based on the third research question, we further considered what access challenges might exist within our participants and the distribution of final student grade outcomes across the full group vs. for students with minoritized identities. Our results showed tendencies for more access challenges and lower final outcomes among minoritized students, as well as trends for different levels and types of interaction for these individuals relative to other surveyed students. In this paper, we cover these new results and generally sought to understand potential barriers to interaction during Ecampus courses and current experiences with any existing synchronous (and the more common asynchronous) interaction in Ecampus coursework across a variety of academic content domains.

## Methods

We broadly surveyed students enrolled in Ecampus STEM courses at Oregon State University, including campus-based students taking online courses as well as fully remote learners, using an IRB-approved online 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). We also asked about amounts of time engaging with instructors and peers in different ways during Ecampus coursework. For more detailed information about the survey structure and types of survey questions, see Appendix A. 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.

### Procedure

Participants were recruited through emails to the instructors of relevant STEM Ecampus courses (e.g., ENGR 103 [Engineering Computation and Algorithmic Thinking], CS 475 [Introduction to Parallel Programming], PSY 350 [Human Lifespan Development], BI 205 [Introductory Biology II]) 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 of the selected courses have some opportunity for non-mandatory synchronous interaction (e.g., videoconferencing-based office hours or Discord voice channels).
We circulated the survey during each term of the 2022-23 academic year. The survey was distributed around the mid-point of each 10-week term to ensure that students gained a sense of the course before reporting on their experiences in the study.

The study survey was self-contained in Qualtrics and collected the information mentioned in the previous subsection. Upon completing the survey, respondents could elect to enter a drawing for a $10 Amazon gift card.

**Participants**

Fifty-eight 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). Forty-three 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." Note that responses could include multiple racial identities. Fourteen participants were first-generation college students, and four participants were veterans of the US Armed Forces.

**Analysis**

Initial data analysis of aggregate data was presented to the ASEE 2024 conference (Sanchez et al., 2024). In the current manuscript, we take a more individualized approach, considering participants with minoritized identities that might put them at higher risk for Ecampus access challenges, participant data that signaled some type of access issue or other barrier to success, and the intersection of the two groups (i.e., students with minoritized identities and students who experienced access barriers).
When considering minoritized identities, we focused on a subset of the survey participants from the following groups:

- Members of the following racial groups that are underrepresented in STEM based on the US National Science Foundation's definitions: Latino, American Indian/Alaska Native, Black, and Pacific Islander ($n$ = 8).
- First-generation students ($n$ = 14), one common minoritized group on campus due to the relatively large rural population in Oregon.
- Students with veteran status in the US Armed Forces ($n$ = 4).

Although other groups may also be at risk within STEM (e.g., women, non-binary and trans people), the groups used here have been previously identified as at-risk when pursuing STEM education and careers. For example, although 43% of veterans pursue STEM degrees, only 8% work in STEM fields.[1]

When looking at student experiences and achievement, we focused on the following scale-wise survey question responses or final grade outcomes that seemed indicative of risk:

- Participants who reported using unreliable electronic devices to access Ecampus content ($n$ = 1).

[1] https://www.whitehouse.gov/wp-content/uploads/2021/12/12-21_CoSTEM-STEM-Vets-Plan.pdf

- Those who reported a low or moderate contentment with their internet connection for videoconferencing (*n* = 5).

- Individuals who did not have a private or semi-private space from which to videoconference (*n* = 1).

- Participants who received any grade of C+ or lower in any Ecampus course (*n* = 7).

The challenges listed above indicate potential access issues, as well as lower performance outcomes that could potentially interfere with degree progress.

A trained coder from the research team performed a thematic analysis of the free-response survey data using a constant comparison method with an open coding phase and focused coding phase (Glaser et al., 1965). The coder reviewed the free-response input to the final portion of the survey, as detailed in Appendix A, until saturation was achieved, and themes emerged from the data (Sloane et al., 2024). In this paper, we present the percentage of the group of students with minoritized identities that mentioned each emergent theme, in addition to the percentage of all participants who articulated each theme. We performed an inter-rater reliability analysis by having a second trained coder label 10% of the data with the same theme codebook. The resulting Cohen's kappa was 0.70, which indicates a substantial level of inter-rater reliability.

## Results

This section includes *a priori* planned results related to access experiences and course outcomes for students with minoritized identities in STEM, as well as exploratory results that may help explain the results from the a priori analyses.

### Participant Ecampus Coursework Experience

Information on the 58 participants' past experience taking Ecampus courses appears in Table 1. Participants' experience included a broad range of Oregon State University STEM offerings.

**Table 1.** Past Ecampus course experience levels from the study sample (N=58).

| # Classes | Count | % of Sample |
|---|---|---|
| 1 | 6 | 10.3% |
| 2-4 | 16 | 27.6% |
| 5-8 | 12 | 20.7% |
| 9+ | 24 | 41.4% |

### A Priori Planned Results

We wondered if possessing a minoritized identity and/or experiencing access issues captured by the survey would affect student experiences and performance in classes. One way we can consider this experience is by checking who in the dataset experienced access issues that may influence their course performance and experience. Specifically, we considered students who reported unreliable computers/tablets to access coursework (*n* = 1), those who were not fully happy with their internet connection (*n* = 5), and students who did not have private or semi-private spaces from which to videoconference (e.g., for attending virtual office hours; *n* = 1). These problems affected seven total individuals in the dataset (i.e., no participants experienced multiple overlapping problems from this set). Although only 34.5% (*n* = 20) of the 58 total respondents belonged to an underrepresented race in STEM, were first-generation college students, and/or were US military veterans, four out of seven of those who identified access obstacles came from this minoritized subset of the respondents. This result may highlight an increased infrastructure risk for students from minoritized groups who engage in Ecampus coursework that are not always considered closely before students enroll in such educational activities.

The results of the survey also show that the students who received a grade of 'C+' or lower (*n* = 7) in at least one Ecampus course disproportionately included students with minoritized identities (one of whom also experienced network problems during their Ecampus coursework). Once again, while 34.5% of the 58 total respondents belonged to the minoritized groups noted in Table 2, four of the lower Ecampus grades (out of 7) were received by this group. As above, we want to emphasize that this relationship is not necessarily causal, but the trend may merit more follow-up investigation to help elucidate resource needs in Ecampus teaching.

**Table 2.** Information on students within the sample, which may help to highlight any relationships between intersectional identities, technology access barriers, and grades.

| ID | Under-represented Race | First Generation | Veteran | Unreliable Tech | Bad Network | Public Video-conference | Low Grade |
|---|---|---|---|---|---|---|---|
| 1 | | | Y | | | | |
| 2 | | | Y | | | | |
| 3 | Y | Y | | | Y | | |
| 4 | | | | | Y | | |
| 7 | Y | Y | | Y | | | |
| 12 | | Y | | | | | |
| 14 | Y | | | | Y | | Y |
| 17 | | | Y | | Y | | |
| 18 | | | | | | | Y |
| 19 | Y | Y | Y | | | | |
| 20 | | Y | | | | | Y |
| 21 | | Y | | | | | Y |
| 28 | | Y | | | | | |
| 29 | | Y | | | | | |
| 35 | Y | Y | | | | | |
| 41 | | Y | | | | | |
| 43 | | | | | | Y | |
| 47 | | | | | | | Y |
| 48 | Y | | | | | | |
| 49 | Y | Y | | | | | |
| 50 | | Y | | | | | |
| 52 | | Y | | | | | |
| 54 | | Y | | | | | |
| 56 | | | | | Y | | |
| 57 | | | | | | | Y |
| 58 | Y | | | | | | Y |

**Exploratory Results**

We considered that survey results that also could highlight possible mechanisms that influence the student experiences and outcomes from the previous subsection. Specifically, the survey included questions about the amount of time spent interacting with peers and instructors during Ecampus coursework, as well as written responses to questions about the Ecampus experience. We wondered if the subset of the respondents with minoritized identities sought or experienced Ecampus courses in a different way, which might be captured by data from the above-mentioned questions.

**Interaction Type**

We used descriptive statistics from the interaction time self-reports in the survey to begin our exploratory analysis. As shown in Table 3, the trends in interaction mode show that although students from the studied minoritized groups reported spending as many hours or more interacting with classmates and instructors as other students overall, the distribution of time tends to be different. These students reported spending more time in asynchronous interaction, and less time in synchronous interaction; both in terms of interactions with peers and for interactions with the teaching team.

**Table 3.** Self-reported hours of interaction with peers and instructors by all students who responded to the survey vs. students with the minoritized identities.

| | **Asynchronous Interaction w/Peers** | **Synchronous Interaction w/Peers** | **Asynchronous Interaction w/Instructors** | **Synchronous Interaction w/Instructors** |
|---|---|---|---|---|
| | M+SD | | | |
| Full Dataset | 6.0 ± 5.6 | 1.7 ± 3.0 | 4.6 ± 5.9 | 1.4 ± 3.1 |
| Minoritized Students | 7.7 ± 7.0 | 1.0 ± 1.2 | 7.3 ± 7.9 | 0.8 ± 1.2 |

Note: Results are reported as mean plus or minus standard deviation, with the units of hours per week.

**Content Analysis**

We also considered the breakdown of free-response themes between different groups in our sample, where the free response questions focused on reasons for taking Ecampus coursework, advantages of Ecampus coursework, and disadvantages of Ecampus coursework. The results in Table 4 illustrate the seven most common emergent themes in the dataset as shown in the codebook. Six of the seven themes illustrated in Table 4 were mentioned by a higher percent of the students from minoritized groups than percent of survey participants overall. These themes specifically highlighted flexibility and the remote coursework location as the most common positive aspects of Ecampus classes. Participants reported lower interaction rates with peers and instructors as the most common downside, and once again this was roughly 10% higher in minoritized students, likely reflecting the trends observed in Table 3, where these students reported spending less time on synchronous interaction and more so using asynchronous methods. This trend suggests the possibility that the flexible nature of Ecampus learning is at odds with the type or quality of interaction it actually affords the surveyed students and subsequently might impact their experience within the Ecampus coursework. For brevity, Table 4 includes all codes mentioned by 30.0% or more of the group of minoritized students, vs. the analogous percentage from the full respondent group.

Additional emergent reasons to take Ecampus classes that were mentioned by more than one participant were: cost ($n$ = 10 participants), postbaccalaureate ($n$ = 7), offerings or instructor ($n$ = 7), liking the nature of Ecampus learning ($n$ = 6), health reasons ($n$ = 4), and convenience ($n$ = 3). Additional Ecampus pro themes included personal obligations ($n$ = 8), the ability to rewind ($n$ = 7), course discussion boards ($n$ = 5), cost of classes ($n$ = 3), networking opportunities ($n$ = 3), the nature of Ecampus classes ($n$ = 3), health ($n$ = 2), and alleviation of social anxiety ($n$ = 2). For Ecampus disadvantages, students also mentioned limitations in course content ($n$ = 12 participants), cost of classes ($n$ = 3), missing the college experience ($n$ = 3), less feeling of engagement ($n$ = 3), confusion about course logistics ($n$ = 3), less personal feedback ($n$ = 2), less accommodation for student needs ($n$ = 2), and the occasional stigma of online education ($n$ = 2).

**Table 4.** Thematic code occurrences in the full survey responses vs. those of student participants from minoritized groups.

| | **Reason for Taking Ecampus Course** | | | | **Ecampus Pros** | | **Ecampus Cons** |
|---|---|---|---|---|---|---|---|
| | Location | Flexibility | Cost | Additional Responsibilities[2] | Flexibility | Location | Lower Interaction |
| Full Dataset | 53.4% | 41.4% | 17.2% | 29.3% | 82.8% | 27.6% | 77.6% |
| Minoritized Students | 65.0% | 55.0% | 30.0% | 25.0% | 90.0% | 35.0% | 85.0% |

## Discussion

Based on our analysis, students with minoritized identities in STEM tended to experience more access challenges related to Ecampus coursework, as well as tending to receive more final grades of C+ or lower, compared to the full sample. Intersectionality was common in the dataset, with three of the minoritized students possessing multiple minoritized identities; related work shows that such intersectionality can present heightened risk of access challenges (Cochran et al., 2020). The most common access problem observed in the dataset was network connection problems, with occasional challenges related to computer hardware or physical spaces for videoconferencing. We noticed a tendency for students with minoritized identities to report more asynchronous but less synchronous interaction compared to the broader sample. Future work could seek to clarify if this difference in interaction strategies replicates, and if it might serve as a possible explanation for the trend of worse performance by a subset of students. While the students with minoritized identities reported seeking Ecampus coursework more commonly for its flexibility (compared to the full participant sample), they were also more likely to lament the lower rates of Ecampus interaction. The contradicting forces highlighted by these results show that further work may be needed to determine how to best support the success of underrepresented learners in Ecampus coursework and provide them with the desired amount of flexibility but simultaneously increase their satisfaction with course-related interactions.

This paper discusses the results of a broad Ecampus student survey that can help elucidate challenges and differences in experience during this course modality. Although the findings could be strengthened through larger samples and broader demographics, which would offer more statistical power and representation of experiences, the presented first step is helpful for generating future hypotheses. Our next steps in this research will use the same survey instrument with larger groups of participants from a range of college campuses to clarify what findings may be specific to our student population and which may be more broadly generalizable. 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

[2] These responsibilities included obligations such as full-time work and raising children in parallel with taking courses, as a few examples.

theoretical investigation into these important but complex pedagogical questions.

## References


Alhazbi, S., & Hasan, M. A. (2021). The role of self-regulation in remote emergency learning: Comparing synchronous and asynchronous online learning. *Sustainability*, *13*(19), 11070. https://doi.org/10.3390/su131911070

Banerjee, M. (2020). An Exploratory Study of Online Equity: Differential Levels of Technological Access and Technological Efficacy Among Underserved and Underrepresented Student Populations in Higher Education. *Interdisciplinary Journal of e-Skills and Lifelong Learning*, *16*, 93-122. http://www.ijello.org/Volume16/IJELLv16p093-121Banerjee6456.pdf

Blayone, T. J., Barber, W., DiGiuseppe, M., & Childs, E. (2017). Democratizing digital learning: Theorizing the fully online learning community model. *International Journal of Educational Technology in Higher Education*, *14*(1), 1-16. https://doi.org/10.1186/s41239-017-0051-4

Boston, W. E., & Ice, P. (2011). Assessing retention in online learning: An administrative perspective. *Online Journal of Distance Learning Administration*, *14*(2). https://ojdla.com/archive/summer142/boston_ice142.pdf

Cochran, G. L., Boveda, M., & Prescod-Weinstein, C. (2020). Intersectionality in STEM Education Research. In *Handbook of Research on STEM Education* (pp. 257-266). Routledge.

Cullinan, J., Flannery, D., Harold, J., Lyons, S., & Palcic, D. (2021). The disconnected: COVID-19 and disparities in access to quality broadband for higher education students. *International Journal of Educational Technology in Higher Education*, *18*, 1-21. https://doi.org/10.1186/s41239-021-00262-1

de la Torre, L., Heradio, R., Jara, C. A., Sanchez, J., Dormido, S., Torres, F., & Candelas, F. A. (2013). Providing collaborative support to virtual and remote laboratories. *IEEE Transactions on Learning Technologies*, *6*(4), 312-323. https://doi.org/ 10.1109/TLT.2013.20

Dumford, A. D., & Miller, A. L. (2018). Online learning in higher education: Exploring advantages and disadvantages for engagement. *Journal of Computing in Higher Education*, *30*(3), 452-465. https://doi.org/10.1007/s12528-018-9179-z

Francescucci, A., & Rohani, L. (2019). Exclusively synchronous online (VIRI) learning: The impact on student performance and engagement outcomes. *Journal of Marketing Education*, *41*(1), 60-69. https://doi.org/10.1177/0273475318818864

Gardner, K., & Leary, H. (2023). Online Learning for First-Generation and Underrepresented Minoritized Students: A Literature Review Using a Model of Student Engagement. *Online Learning*, *27*(1), 263-291. https://eric.ed.gov/?id=EJ1382645

Glaser, B. G. (1965). The constant comparative method of qualitative analysis. *Social Problems*, *12*(4), 436-445. https://doi.org/10.2307/798843

Graves, J. M., Abshire, D. A., Amiri, S., & Mackelprang, J. L. (2021). Disparities in technology and broadband internet access across rurality: implications for health and education. *Family & Community Health*, *44*(4), 257-265. https://doi.org/10.1097/FCH.0000000000000306

Hachey, A. C., Conway, K. M., Wladis, C., & Karim, S. (2022). Post-secondary online learning in the US: An integrative review of the literature on undergraduate student characteristics. *Journal of Computing in Higher Education*, 34(3), 708-768. https://doi.org/10.1007/s12528-022-09319-0

Hachey, A. C., Wladis, C. W., & Conway, K. M. (2013). Balancing retention and access in online courses: Restricting enrollment... Is it worth the cost? *Journal of College Student Retention: Research, Theory & Practice*, *15*(1), 9-36. https://doi.org/10.2190/CS.15.1.b

Houlden, S., & Veletsianos, G. (2019). A posthumanist critique of flexible online learning and its "anytime anyplace" claims. *British Journal of Educational Technology*, *50*(3), 1005-1018. https://doi.org/10.1111/bjet.12779

Joosten, T., & Cusatis, R. (2020). Online Learning Readiness. *American Journal of Distance Education*, 34(3), 180–193. https://doi.org/10.1080/08923647.2020.1726167

Kahn, S., Vertesi, J., Adriaenssens, S., Byeon, J., Fixdal, M., Godfrey, K., ... & Wagoner, K. (2022). The impact of online STEM teaching and learning during COVID-19 on underrepresented students' self-efficacy and motivation. *Journal of College Science Teaching*, *51*(6), 6-15. https://doi.org/10.1080/0047231X.2022.12315644

Kuo, Y. C., Walker, A. E., Belland, B. R., Schroder, K. E., & Kuo, Y. T. (2014). A case study of integrating Interwise: Interaction, internet self-efficacy, and satisfaction in synchronous online learning environments. *International Review of Research in Open and Distributed Learning*, *15*(1), 161-181. https://doi.org/10.19173/irrodl.v15i1.1664

Humiston, J. P., Marshall, S. M., Hacker, N. L., & Cantu, L. M. (2020). Intentionally creating an inclusive and welcoming climate in the online learning classroom. In *Handbook of Research on Creating Meaningful Experiences in Online Courses* (pp. 173-186). IGI Global.

Martin, F., & Bolliger, D. U. (2018). Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online Learning*, *22*(1), 205-222. https://eric.ed.gov/?id=EJ1179659

Martin, F., Sun, T., Turk, M., & Ritzhaupt, A. D. (2021). A meta-analysis on the effects of synchronous online learning on cognitive and affective educational outcomes. *International Review of Research in Open and Distributed Learning*, *22*(3), 205-242. https://doi.org/10.19173/irrodl.v22i3.5263

Oztok, M., Zingaro, D., Brett, C., & Hewitt, J. (2013). Exploring asynchronous and synchronous tool use in online courses. *Computers & Education*, *60*(1), 87-94. https://doi.org/10.1016/j.compedu.2012.08.007

Parsad, B., Lewis, L., & Tice, P. (2008). *Distance education at degree-granting postsecondary institutions: 2006-2007* (pp. 90-95). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, US Department of Education.

Phirangee, K., & Malec, A. (2017). Othering in online learning: An examination of social presence, identity, and sense of community. *Distance Education*, *38*(2), 160-172.

Sanchez, C. A., Zhang, B. J., & Fitter, N. T. (2024). Toward Understanding Impacts of Ecampus Course Synchronicity on STEM Learners. Accepted to the 2024 ASEE Annual Conference.

Shaikh, U. U., & Asif, Z. (2022). Persistence and dropout in higher online education: Review and categorization of factors. *Frontiers in Psychology*, 13, 902070. https://doi.org/10.3389/fpsyg.2022.902070

Sloane, B. M., Kenyon, L. K., Logan, S. W., & Feldner, H. A. (2024). Caregiver perspectives on powered mobility devices and participation for children with cerebral palsy in Gross Motor Function Classification System level V. *Developmental Medicine & Child Neurology*, *66*(3), 333-343. https://doi.org/10.1111/dmcn.15718

Wester, E. R., Walsh, L. L., Arango-Caro, S., & Callis-Duehl, K. L. (2021). Student engagement declines in STEM undergraduates during COVID-19–driven remote learning. *Journal of Microbiology & Biology Education*, *22*(1), 10-1128. https://doi.org/10.1128/jmbe.v22i1.2385

Wladis, C., Conway, K., & Hachey, A. C. (2017). Using course-level factors as predictors of online course outcomes: A multi-level analysis at a US urban community college. *Studies in Higher Education*, *42*(1), 184-200. https://doi.org/10.1080/03075079.2015.1045478

Wladis, C., Hachey, A.C. & Conway, K.M. (2014). An investigation of course-level factors as predictors of online STEM course outcomes. *Computers & Education*, 77, 145-150. https://doi.org/10.1016/j.compedu.2014.04.015

Xu, D. and Jaggars, S. (2013). "Adaptability to online learning: Differences across types of students and academic areas (CCRC Working Paper #54)." New York, New York: Columbia University, Teachers College, Community College Research Center. https://eric.ed.gov/?id=ED539911

Yamagata-Lynch, L. C. (2014). Blending online asynchronous and synchronous learning. *International Review of Research in Open and Distributed Learning*, *15*(2), 189-212. https://doi.org/10.19173/irrodl.v15i2.1778

Zamecnik, A., Kovanović, V., Joksimović, S., & Liu, L. (2022). Exploring non-traditional learner motivations and characteristics in online learning: A learner profile study. *Computers and Education: Artificial Intelligence*, 3, 100051. https://doi.org/10.1016/j.caeai.2022.100051

Zhu, Y., Zhang, J. H., Au, W., & Yates, G. (2020). University students' online learning attitudes and continuous intention to undertake online courses: A self-regulated learning perspective. *Educational Technology Research and Development*, 1-35. https://doi.org/10.1007/s11423-020-09753-w

**Appendix A**

The survey sections collected the following information.

- *Opening portion:* text entry, multiple-choice, select-all-that-apply questions on:
  - Current Ecampus enrollment: text entry field for providing the full list.
  - Cumulative amount of Ecampus coursework experience: multiple-choice with four range options, i.e., 1, 2-4, 5-8, or 9+.
  - Typical devices used to access Ecampus content: select-all-that-apply list with many provided options, plus a field for providing additional written-in selections.
  - Past applications, tools, and websites used for Ecampus courses: select-all-that-apply list with many provided options, plus a field for providing additional written-in selections.
  - Videoconferencing use question: yes/no question about videoconferencing use during Ecampus coursework.
  - Video lecture question: yes/no question about viewing videos online during Ecampus coursework.
- *Middle portion:* Likert-type, multiple-choice, select-all-that-apply, slider questions on:
  - Physical location from which students typically access Ecampus course content: multiple-choice for indicating how often each location (i.e., home, on campus, in a public location not on campus, and write-in other) was used (i.e., very frequently, sometimes, rarely, never).
  - Most common internet browser for Ecampus work: multiple-choice including common browsers and a field for providing written-in selections.
  - For those who indicated use of a phone and/or tablet for class:
    - A 7-pt Likert-type scale on network type from full cellular data use to full WiFi use, with different levels of split in the middle.
    - A select-all-that-apply question about what applications students have downloaded for Ecampus activities, including provided choices and a field for providing written-in selections.
  - For those who indicated videoconferencing experience for Ecampus work:
    - Multiple-choice questions about camera used, microphone used, and videoconferencing location.
    - 7-pt Likert-type scale from “Strongly disagree” (1) to “Strongly agree” (7) for network quality. (All Likert-type scales mentioned below also used these same anchor points.)
  - For those who indicated video lecture engagement, video playback quality, production quality, and helpfulness for learning: administered on 7-pt Likert-type scales.
  - For all selected devices used to access Ecampus coursework (from the Opening portion):
    - Multiple-choice questions for indicating how often each device was used for class (i.e., very frequently, sometimes, rarely) and how often the participant had access to the device (i.e., personal device, shared device with good access, shared device with limited access).
    - Select-all-that-apply questions about what course components (i.e., lectures, homework, video calls, online discussions, quizzes, and/or exams) participants accessed on that device.
    - Slider questions to indicate the device’s age, from 0 to 15 years old.
    - 7-pt Likert-type questions on device reliability.
  - For all selected applications/tools/websites (from the Opening portion):

        - 7-pt Likert-type questions about comfort using each tool.
        - 7-pt Likert-type questions about each tool's value for learning.
    - Levels of asynchronous and synchronous interaction with peers and instructors during the course: reported using slider questions from 0 to 20 hours per week.
- *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

## About the Research Unit at Oregon State Ecampus

**Vision**

The Ecampus Research Unit strives to be leaders in the field of online higher education research through contributing new knowledge to the field, advancing research literacy, building researcher communities and guiding national conversations around actionable research in online teaching and learning.

**Mission**

The Ecampus Research Unit responds to and forecasts the needs and challenges of the online education field through conducting original research; fostering strategic collaborations; and creating evidence-based resources and tools that contribute to effective online teaching, learning and program administration.

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