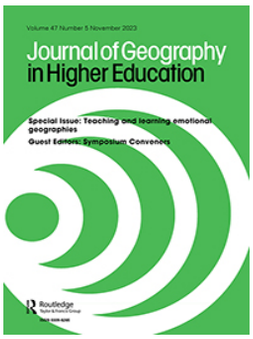

Routledge
Taylor & Francis Group

Journal of Geography in Higher Education

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/cjgh20

Assessing the influence of traditional in-seat, online, and emergency remote teaching (ERT) modalities on sustainability learning in human geography

Benjamin McCormick, Christopher A. Craig, Susan Gilbertz, Brittany Wood & Ismail Karabas

To cite this article: Benjamin McCormick, Christopher A. Craig, Susan Gilbertz, Brittany Wood & Ismail Karabas (16 Feb 2024): Assessing the influence of traditional in-seat, online, and emergency remote teaching (ERT) modalities on sustainability learning in human geography, Journal of Geography in Higher Education, DOI: 10.1080/03098265.2024.2316701

To link to this article: https://doi.org/10.1080/03098265.2024.2316701

Published online: 16 Feb 2024.

JOURNAL OF GEOGRAPHY IN HIGHER EDUCATION
https://doi.org/10.1080/03098265.2024.2316701

Routledge
Taylor & Francis Group

ARTICLE

Assessing the influence of traditional in-seat, online, and emergency remote teaching (ERT) modalities on sustainability learning in human geography

Benjamin McCormick[a], Christopher A. Craig[a], Susan Gilbertz[b], Brittany Wood[c] and Ismail Karabas[a]

[a]Arthur J. Bauernfeind College of Business, Murray State University, Murray, KY, USA; [b]College of Business, Montana State University Billings, Billings, MT, USA; [c]Political Science, College of Humanities and Fine Arts, Murray State University, Murray, KY, USA

ABSTRACT

Globally, the disruptions to higher education caused by COVID-19 required most campuses to make impromptu shifts to emergency remote teaching (ERT). When compared to traditional online education, ERT generally falls short in terms of pedagogies, pacing, and/or successful modality implementation. Elsewhere, it is established that the sudden shift towards online and asynchronous ERT delivery creates student challenges, especially in terms of internet unavailability and social disconnectedness. What remains understudied is the impact of COVID-19 on actual student learning. We address this knowledge gap using a natural research design where we (i) evaluated sustainability learning for traditional in-seat and online human geography students in Fall 2018 and (ii) obtained federal funding to evaluate sustainability learning for ERT and online students in Spring 2020. Results from the analysis indicate that in-seat students outperformed online students prior to COVID-19 on a standardized sustainability knowledge assessment by 13%. Results also indicate that in-seat students prior to COVID-19 (Fall 2018) outperformed ERT students (Spring 2020) by 28%. Discussion and limitations are provided.

ARTICLE HISTORY
Received 4 June 2023
Accepted 10 January 2024

KEYWORDS
Emergency remote teaching (ERT); sustainability; human geography; modality; COVID-19

Introduction

Prior to COVID-19, in-seat instruction was the hallmark of higher education. In fact, in the United States almost 66% of the students had never enrolled in an online course (National Center for Education Statistics NCES, 2020) and 64% of the instructors had not taught an online course (N. Johnson et al., 2020). As COVID-19 forced colleges and universities to make sudden shifts to online formats, two salient barriers to online education became apparent: (i) access to the necessary technologies by students and instructors and (ii) the pedagogical expertise needed to operate an effective online classroom (e.g. Hassan et al., 2020; Hodges et al., 2020; Kimble-Hill et al., 2020; Winter et al., 2021). Despite the challenges, by March 2020 higher education institutions around the world had adopted online instruction as the primary, if not the only, delivery option.

CONTACT Christopher A. Craig ccraig8@murraystate.edu Arthur J. Bauernfeind College of Business, Murray State University, Murray, KY 42071, USA

The instruction that would follow was not true online education, rather, a haphazard counterpart classified as emergency remote teaching (ERT) (Hodges et al., 2020). According to Hodges et al. (2020), ERT is a result of crisis and is distinguishable from traditional online education because it is deficient in one or more foundational areas: pedagogy, pacing, modality, instructor role online, source of feedback, and role of online assignments. The impromptu transition to ERT required students and instructors alike to familiarize themselves with asynchronous instruction via learning management systems (e.g. Canvas, Desire 2 Learn [D2L], and Blackboard) and synchronous online classrooms using communication applications (e.g. Zoom and Google Hangouts) (e.g. N. Johnson et al., 2020). The widespread adaptation of online instruction quickly legitimized the medium, necessitating a better understanding of ERT and how students respond differently to ERT than traditional instructional methods.

To address this research gap, we investigated differences in learning before and during the height of COVID-19 dependent on delivery modality at a regional university in the Western United States. We were uniquely positioned to investigate differences because we introduced and evaluated an interdisciplinary (i.e. business and STEM) sustainability module in a Human Geography course for in-seat and online students Fall 2018. With the realization of COVID-19 Spring 2020, we received rapid National Science Foundation (NSF) funding to study the effects of COVID-19 on student learning. Upon receipt of funding and expedited IRB approval, students from two course sections (one ERT, one traditional online) received the sustainability module and student learning was once again assessed. The research design is known as a natural experiment, which entails data collection prior to a natural event/disaster (e.g. COVID-19 and hurricane) and then again after the event/disaster (Hein et al., 2019).

Below, we begin by providing a brief overview of the sustainability curriculum students received before and during COVID-19. Next, we review select literature about ERT and traditional instructional methods (i.e. in-seat, online), offering three research questions. We then provide methods, results and analysis, and discussion sections complete with limitations.

Sustainability module

The original interdisciplinary sustainability module was designed, developed, implemented, and evaluated as part of an NSF grant that introduced business and sustainability into STEM disciplines (e.g. Human Geography) and STEM and sustainability into business disciplines (Petrun Sayers et al., 2020). The sustainability module deployed in Human Geography was created using two systems of instructional design: the ADDIE (analyze, design, develop, implement, evaluate) (Chevalier, 2011) system and Bloom's revised taxonomy (Krathwohl, 2002). The ADDIE system aligns an educational intervention (i.e. a sustainability module) with an outcome (i.e. sustainability learning) and is one of the most commonly used systems for instructional design. Table 1 demonstrates our adaptation of the ADDIE system (Chevalier, 2011). Bloom's revised taxonomy was applied to the design phase, namely progressing module-level learning objectives from Bloom's first (remember) to fifth (evaluate) level of learning (Krathwohl, 2002). The full list of learning objectives is available elsewhere (Gilbertz & Hall, 2022).

Table 1. ADDIE model.

Stage	Action
Analyze	Identify performance gaps in sustainability knowledge
Design	Gap oriented content outline and learning objectives created
Development	Gap oriented materials, activities, and assignments created
Implement	Sustainability module deployed
Evaluate	Sustainability learning measured

The sustainability module duration was 3 weeks, covering the: economic (Week 1), environmental (Week 2), and social (Week 3) cases of sustainability along the Yellowstone River Valley corresponding with the Gilbertz and Hall (2022) text. In 2018, the in-seat section of Human Geography ran in parallel with the online section. During the in-seat section, the instructor would audio record the lectures corresponding with PowerPoint slides. The recordings were made available to online students within a matter of hours to provide the context necessary to interpret the PowerPoints. In addition to lectures and PowerPoints, the other primary learning activities were discussions, which occurred as break-out sessions for in-seat students and via online discussion boards for online students. In 2020, the sustainability module had not been delivered when COVID-19 forced the shift to ERT. The disruption resulted in ERT students (previously in-seat) receiving the same asynchronous online delivery as traditional online students, with pre-recorded lectures from 2018 and PowerPoint slides the two primary learning activities in addition to online discussion boards.

Results from the original 2018 student assessment provide robust research-based evidence of the effectiveness of sustainability curriculum. First, using a pre-/post-test design, improvement in sustainability learning was observed for students who participated in sustainability educational interventions (i.e. treatment) but not for comparable students who did not participate in the curriculum (i.e. counterfactual) (Craig, Petrun Sayers, Gilbertz, Karam, et al., 2022). Learning was assessed using the previously validated Sustainability Knowledge Assessment (ASK; Zwickle et al., 2014), an instrument that assesses the three dimensions (i.e. economic, environmental, and social) of sustainability derived from the United Nations Sustainable Development Goals. Qualitative assessment (i.e. cognitive mapping) using a pre-/post-test research design provides evidence that treatment students demonstrated a more interconnected and comprehensive understanding of sustainability topics than counterfactual students (Petrun Sayers et al., 2021).

Combined, research-based evidence from assessment activities demonstrates the positive impacts of interdisciplinary sustainability curriculum on student learning. A knowledge gap that remains, however, is the influence of instructional delivery (i.e. ERT, in-seat, and online) on learning in the midst of COVID-19. We address this research gap by exploring differences in sustainability learning for students who received each form of delivery in a Human Geography course.

Emergency remote teaching

There are a host of challenges that emerged with ERT. To begin, instructors were compelled to update lesson plans and incorporate various online mediums into course delivery (Wahab, 2020). However, many students and instructors were neither versed in, nor accustomed to, the online learning environment, whether that be asynchronous or synchronous delivery (e.g. N. Johnson et al., 2020; National Center for Education

Statistics (NCES, 2020; Trust & Whalen, 2020). Even for instructors who had previously taught online courses, 51% reported they were unfamiliar with some of the teaching methods necessitated by ERT (N. Johnson et al., 2020). Three of the most salient challenges faced by instructors included: (i) feeling overwhelmed, (ii) student lack of internet, and (iii) lack of knowledge about online teaching (Trust & Whalen, 2020).

Some higher education instructors and institutions responded more effectively to ERT than others. For instance, Gares et al. (2020) focused on maintaining high levels of engagement among students measured as follows: (i) class attendance, (ii) completion of assignments, and (iii) participation in online activities. An adaptive measure to facilitate engagement was to blend synchronous and asynchronous deliveries, allowing students the benefits of social interaction and self-paced learning (Gares et al., 2020). Gares et al. (2020) report that rich interactions with students resulted in higher attendance and also completion rate for the course. Administratively, a widely adopted measure to help facilitate course completion was a pass/fail system of grading (e.g. Gelles et al., 2020; Hussain et al., 2020).

Despite the best efforts among instructors and institutions, student experiences with the ERT learning environment were negative (e.g. Dvoráková et al., 2021; Shin & Hickey, 2021). For example, Shin and Hickey (2021) conducted a survey finding students were generally dissatisfied with ERT; the most common complaint was the lack of quality instruction. Students also reported a lack of social interaction (e.g. class meetings, discussions, and labs), which in turn adversely impacted educational experience and mental health (Dvoráková et al., 2021; Shin & Hickey, 2021). Specific to geography education, virtual environments necessitated by ERT hindered student learning (Li et al., 2023). West et al. (2023) identified four key challenges geography students faced with ERT transitions including time management, maintaining motivation, engaging in online classes, and feeling isolated in an online learning community. Further complicating matters, some students did not have the internet to attend synchronous class sessions or complete asynchronous assignments (N. Johnson et al., 2020). These are just a few instances of student struggles; instructors around the world observed "record numbers of students checked out, stressed out, and unsure of their future" (McMurtrie, 2022, part I).

Traditional instruction

Traditional in-seat and online instruction have differences and similarities. The most obvious distinction between the two is modality. Online education can be synchronous, asynchronous, or hybrid, whereas traditional in-seat education has been done in real-time. A primary benefit of online education is the flexibility it warrants (Appana, 2008). Today, many in-seat courses have begun to harness asynchronous components, a hybrid structure offering students the benefits of online education. Regardless of the content or medium of delivery, student engagement is necessary for learning to occur (Khan et al., 2017). This lack of engagement is directly related to a decline in active learning, which in turn decreases student performance (Khan et al., 2017). Dumford and Miller (2018) highlighted that the reliance on asynchronous elements for online instruction is detrimental to collaborative learning and interaction among students. The authors contend that adding more group work and synchronous interactions can combat negative experiences and unfavorable performance outcomes for students. Conversely, the advantages of

traditional in-seat instruction include (i) students and instructors are familiar with the structure and (ii) social cues and face-to-face interaction facilitate student-to-student and instructor-to-student collaboration (Dumford & Miller, 2018).

Historically, a primary obstacle for online education was that students and instructors were unfamiliar with learning management systems (e.g. Canvas and D2L) and online communication tools (e.g. Zoom) (Lockee, 2021). The emergence of ERT changed that; instructors and students alike had to quickly adapt to distance education and in many cases, unfamiliar technologies (e.g. Erdem-Aydin, 2021; N. Johnson et al., 2020; Trust & Whalen, 2020). As a result, hybrid and online instruction – synchronous and/or asynchronous – are now commonplace (De de, 2022). Within the changing landscape of instruction, what remains understudied is whether student learning differs based on instructional type: ERT, in-seat, or online. We offer three exploratory research questions:

Research Question 1: Prior to the COVID-19, did student learning differ for in-seat and online students?

Research Question 2: During the COVID-19, did student learning differ for ERT and online students?

Research Question 3: Did student learning differ for in-seat and ERT students?

Methods and materials

The sample consists of 98 students across four sections of Human Geography including an in-seat section (Fall 2018, $n = 21$), online section (Fall 2018, $n = 18$), an ERT section during COVID-19 (Spring 2020, $n = 16$), and an online section during COVID-19 (Spring 2020, $n = 43$). Demographics are provided in Table 2. In Fall 2018, students participated in the newly designed, developed, and implemented sustainability educational intervention described in the literature review. The intervention was taught in both in-person and online courses, one synchronously and the other asynchronously with the addition of audio lectures from the in-seat course. In Spring 2020, the interventions were being taught comparably until COVID-19 when the in-seat course impromptu transitioned to a primarily asynchronous section (i.e. the ERT section). There were negligible changes to the online Spring 2020 section.

The survey procedure Fall 2018 involved the instructor sending Qualtrics survey links to assess student learning (i.e. the ASK scale; Zwickle et al., 2014). Additional data collection was not scheduled for the Spring 2020 term until COVID-19 occurred, which prompted NSF leadership to issue a call for proposal for rapid projects that assessed the impact of COVID-19 on learning in real-time. We obtained rapid funding from the NSF to study the effects of COVID-19 on sustainability learning, at which time we obtained expedited IRB approval to once again survey students about sustainability learning (i.e. the ASK).

To determine if differences existed in the demographic make-up of courses, one-way analysis of variance (ANOVA) was run sorted by course (i.e. 2018 in-seat, 2018 online, 2020 ERT, 2020 online). The dependent measure for student learning is the ASK scale

Table 2. Demographics.

Category	In-Seat (2018)	Online (2018)	ERT (2020)	Online (2020)
Age	Mean = 21, Range: 18–32	Mean = 22, Range: 19–34	Mean = 22, Range: 18–30	Mean = 25, Range: 18–48
Gender	Female = 52.6%, Male = 47.6%, Other = 0%	Female = 72.2%, Male = 22.2%, Other = 5.6%	Female = 56.3%, Male = 43.7%, Other = 0%	Female = 76.7%, Male = 23.3% Other = 0%
Race	White/Caucasian = 95.2%, American Indian/Alaska Native = 4.8%	White/Caucasian = 88.9%, American Indian/Alaska Native = 11.1%	White/Caucasian = 87.5%, Black or African American = 6.3% American Indian/Alaska Native = 6.3%	White/Caucasian = 100%
Grade	First year = 38.1%, Sophomore = 19.0%, Junior = 38.1%, Graduate = 4.8%	First year = 5.6%, Sophomore = 50.0%, Junior = 33.3%, Senior = 11.1%	First year = 37.5%, Sophomore = 43.8%, J unior = 18.8%	First year = 44.2%, Sophomore = 25.6%, Junior = 18.6%, Senior-7.0%, Graduate = 4.7%
Party	9.5% Democrat, 38.1% Republican, 23.8% Independent, 9.5% Libertarian, 19.0% Other	22.2% Democrat, 11.1% Republican, 33.3% Independent, 33.3% Other	37.5% Democrat, 37.5% Republican, 6.3% Independent, 6.3%Libertarian, 12.5% Other	14.0% Democrat, 53.5% Republican, 14.0 Independent, 4.7% Libertarian, 14.0% Other
Employment	4.8% Full-Time, 47.6% Part-Time, 47.6% Not employed	33.3% Full-Time, 50.0% Part-Time, 16.7% Not employed	12.5% Full-Time, 68.8% Part-Time, 18.8% Not employed	37.2% Full-Time, 44.2% Part-Time, 18.6% Not employed

Table 3. One-way ANOVA for in-seat (2018), online (2018), ERT (2020), and online (2020) student demographics.

Factor		*df*	*F*	*p*
Age	Between Groups	3	2.921	0.038
	Within Groups	94		
	Total	97		
Gender	Between Groups	3	2.152	0.099
	Within Groups	94		
	Total	97		
Race	Between Groups	3	1.663	0.18
	Within Groups	94		
	Total	97		
Grade	Between Groups	3	1.401	0.247
	Within Groups	94		
	Total	97		
Party	Between Groups	3	1.773	0.158
	Within Groups	94		
	Total	97		
Employment	Between Groups	3	4.288	0.007
	Within Groups	94		
	Total	97		

(Zwickle et al., 2014). The original ASK consisted of 16 questions about the three dimensions of sustainability (i.e. economic, environmental, and social) and was validated at a large Carnegie Research 1 designated university in the Midwestern United States. There was one question that was omitted because it was outdated at the time the survey was administered: "Which of the following is the primary reason that gasoline prices have risen over the past several decades in the USA?" The statistical methods used to test our research questions were independent sample t-tests (equal variance not assumed) and effect sizes. These methods allow us to identify statistical differences (*t* statistic) and effect sizes/differences between the means of two groups (*Cohen's d*). Effect sizes range from small (.2) to medium (.6) to large (.8) (Cohen, 1988). Sullivan and Feinn (2012) assert there are circumstances where the effect size (*d*) is a more telling statistic than statistical levels (*p*) (e.g. limited sample size).

Results and analysis

ANOVA analysis indicates there were differences in age and employment. Bonferroni post-hoc tests were run to provide additional insights into where demographic differences were present (see Table 3). For age ($F = 2.921$, $p = .038$, $df = 3$), while there was an observed difference in the ANOVA, the post-hoc test did not indicate a significant difference ($p = .099$). For employment ($F = 4.288$, $p = .007$, $df = 3$), differences emerged for (i) in-seat (2018) and online (2018) students and (ii) in-seat (2018) and online (2020) students. As shown in Table 2, irrespective of terms (2018 or 2020), there were substantially greater online students employed full-time than in-seat (2018) students. An additional ANOVA was run to determine if ASK scores differed based on employment status, finding there was not a significant difference ($F = .556$, $p = .575$, $df = 2$). Taken together, the ANOVA analysis provides evidence demographic make-up had a nominal impact on student sustainability learning.

Table 4 provides descriptives and Table 5 the full list of results. Results from *Research Question 1*, where there were differences between in-seat and online students prior to COVID-19, indicate the relationship approached significance ($p = .06$) at the $p < .05$ level. The effect size, however ($d = .61$) indicates there was a moderate difference when comparing the students. The effect size can be interpreted that there was over a half standard deviation difference between ASK scores for in-seat (2018; 77.78%) and online (2018; 65.19%) students. Results from *Research Question 2*, where there were differences between ERT and online students during COVID-19, indicate there was no statistical difference between the two groups, though there was a small effect size difference in scores ($d = -.36$) indicating superior performance by online students. This finding can be interpreted as online students (2020; 57.98%) scored over a quarter standard deviation higher on the ASK than ERT transitional students (2020; 49.58%). Results from *Research Question 3*, where there were differences between in-seat students (2018) and ERT students (2020), indicate there was a significant difference ($p < .00$) and a very large effect size difference ($d = 1.39$). The effect size can be interpreted that in-seat students (2018; 77.78%) scored almost one and a half standard deviations higher than ERT students (2020; 49.58%) on the ASK, our measure of student learning.

Discussion

COVID-19 resulted in a new world for instructional delivery (De de, 2022). Anecdotally, one has to look no further than higher education job postings to see that institutions are seeking candidates qualified to teach using in-seat, online, and/or hybrid modalities. During the pandemic, researchers conducted numerous studies focused on student experiences and perceptions about learning (e.g. Dvoráková et al., 2021; Gares et al., 2020; Shin & Hickey, 2021). Challenges that could influence student learning were explored, such as: (i) lack of internet connectivity, (ii) unfamiliarity with technologies, (iii) social disconnectedness, and (iv) mental health. What remains understudied, however, is the impact of ERT on student learning. We were able to address this gap, using a natural experimental design to evaluate sustainability learning before COVID-19 (Fall 2018) and during the onset of COVID-19 (Spring 2020).

Table 4. Descriptive statistics for traditional in-seat, traditional online, and ERT modalities.

Class	*N*	*Mean*	*SD*	*SE*
In-Seat (2018)	21	77.78%	.21	.05
Online (2018)	18	65.19%	.19	.05
ERT (2020)	16	49.58%	.19	.05
Online (2020)	43	57.98%	.25	.04

Table 5. Independent sample t-tests and effects sizes.

Independent Sample Pairs	F	Sig.	t	df	p	MD	SE	Cohen's d
In-seat (2018)/Online (2018)	.02	.88	1.95	36.90	.06	.13	.06	.62
ERT (2020)/Online (2020)	2.56	.12	−1.38	34.94	.18	−.08	.06	−.36
In-seat (2018)/ERT (2020)	.08	.78	4.25	34.01	.00	.28	.07	1.39
Online (2018)/Online (2020)	2.35	.13	1.23	41.15	.11	.07	.06	.31

According to Andrade (2018), a common threat to internal validity is selection bias, which randomization can help control. Internal validity refers to the extent to which experimental design and analysis of data answers research questions without introducing bias (Andrade, 2018). Our study was a quasi-randomized, however, requiring that additional analysis be conducted to confirm internal validity (Maciejewski, 2020). Quasi-experimental designs occur when randomization is not possible due to a variety of reasons, including practicality, which is the case in our educational study where students self-selected into their respective course sections. Maciejewski (2020) notes that statistical methods can be utilized to control internal validity threats. Accordingly, we conducted an ANOVA analysis of demographics finding differences emerging between groups for (i) age and (ii) employment. As in our study, differences in age and employment have previously been observed when comparing traditional in-seat and online students, where online students are older and full-time employed at a higher rate (e.g. Craig, Petrun Sayers, Gilbertz, Karam, et al., 2022; G. M. Johnson, 2015). For age, however, the Bonferroni post-hoc test did not indicate a significant difference in the age composition of courses. An additional one-way ANOVA was run analyzing ASK scores sorted by employment (i.e. full-time employed, part-time employed, and not employed). Results indicated differences in scores (i.e. our measure of sustainability learning) were not significant (p=.575). Combined, results from the additional analysis provide support that the study findings were internally valid.

Our exploratory study uncovered two primary themes. First, prior to COVID-19, in-seat students who synchronously participated in the interdisciplinary (i.e. business and STEM) sustainability curriculum outperformed asynchronous online students (77.78% v. 65.19%, respectively). While not significant at $p < .10$, the moderate effect size ($d = .61$) is another indication that in-seat students outperformed online students. This finding is consistent with a study that randomly assigned students into face-to-face (treatment) and online (control) sections of an economics course to assess the effectiveness of modalities (Arias et al., 2018). Using a pre- and-test design, treatment students scored significantly higher on a standardized math assessment and instructor questions on the post-test. A key difference between our in-seat and online sections of Human Geography was that in-seat students participated in three in-person breakout discussions, whereas online students participated in online discussions. The other difference is that in-seat students interacted directly with the instructor during lectures, though online students had access to audio recordings of lectures. When students are not engaged and do not participate in active learning, performance suffers (Khan et al., 2017), suggesting the 2018 online section could have benefited from the integration of more active learning strategies (e.g. synchronous touchpoints with instructors and/or peers).

Second, we did not observe a difference between learning for ERT and online students during COVID-19. However, we observed a very strong effect ($t = 4.25$, $p = .00$, $d = 1.39$) when assessing the differences between scores for traditional in-seat (77.78%, Fall 2018) and ERT students (49.58%, Spring 2020). In fact, the effect size was more than double the magnitude of the effect size compared to traditional in-seat and online students (Fall 2018; d=.62). Comparably, Wilhelm et al. (2022) found that ERT students in a Human Anatomy (STEM) lab self-reported lower levels of learning and less competency with course materials. Also, within an international context, Varachotisate et al. (2023) found that in-seat students prior to COVID-19 scored significantly higher on summative

assessment of psychology topics than ERT students. Notably, neither of these studies directly measured learning, a knowledge gap we addressed. Prior to COVID-19, student engagement and active learning were already a challenge in online settings (Khan et al., 2017). A host of attitudinal studies demonstrate that ERT students encountered numerous hurdles (e.g. content delivery preference, internet connectivity, and social disconnectedness) not experienced at the same scale by other modalities, contributing to observed performance declines (e.g. Gares et al., 2020; Shin & Hickey, 2021; Varachotisate et al., 2023; West et al., 2023; Wilhelm et al., 2022).

Practical implications

The article entitled "*Seven principles for practice in undergraduate education*" (Chickering & Gamson, 1987) was a seminal article that provided best practices for the design and development of undergraduate curriculum. Graham et al. (2001) later adapted the seven principles to an online context, referring to the updates as "good practice" for online education (see Table 6). A complicating factor for online pedagogies is that instructors frequently design and develop curriculums from their own perspective, which has proven to be prohibitive to student engagement (Schultz & DeMers, 2020). For instance, Shin and Hickey (2021) and Dvoráková et al. (2021) reported two student challenges were ineffective instruction and lack of engagement, respectively. Within the context of the COVID-19 emergency – what Schultz and DeMers (2020) referred to as a "triage-like environment" – our responsive ERT curriculum (i) did not adequately adhere to good online practices and (ii) was impromptu designed and developed from the instructor's perspective.

When updating the curriculum, an important practical consideration is to consider student preferences and online experiences. For instance, undergraduate students taking sustainability courses prefer synchronous instruction, even if it is a hybrid (Castle & McGuire, 2010). Unfortunately, this was not an option for ERT students because (1) the forced closures of classrooms and (2) the institution did not provide widespread adaptation of synchronous technologies (e.g. video equipment in classes). Two conflating factors for student attendance in synchronous sessions (e.g. Zoom) were (1) lack of internet connectivity/broadband access and (2) insufficient computing technology to attend sessions.

Further, access to synchronous instruction during COVID-19 was inequivalently prohibitive for STEM students (e.g. geographic information systems [GIS], nursing students), who require more hands-on experiences to learn (e.g. data collection, experiments, model building, and procedures) (Hammerness et al., 2022; Schultz & DeMers, 2020; Wilhelm et al., 2022). Our results provide research-based evidence of the power of hands-on

Table 6. Principles of good online practice (adapted from Graham et al., 2001).

1. Encourage contact between students and faculty.
2. Develop reciprocity and cooperation among students.
3. Encourage active learning.
4. Give prompt feedback.
5. Emphasize time on task and task relevance to goals.
6. Communicate high expectations.
7. Respect diverse talents and ways of learning.

experience, considering that in-seat students (2018) outperformed all other course deliveries (Table 4). Instructors from all disciplines were clearly dealing with a host of issues of their own which in many instances hindered synchronous interactions (e.g. Trust & Whalen, 2020). Yet, research-based findings from prior studies – geography (e.g. Thomas & Bryson, 2021; West et al., 2023) or otherwise (e.g. Gares et al., 2020; Khlaif et al., 2021) – provide evidence that the inclusion of more robust synchronous elements and other good online practices (Graham et al., 2001) may have (i) increased student engagement and (ii) moderated declines in sustainability learning in the ERT section of Human Geography. Anecdotally speaking, the rapid adaptation of synchronous classroom technologies by the focal institution – and among its students – in ensuing COVID-19 impacted semesters helped to overcome some of the aforementioned hurdles.

Limitations

While the natural research design allowed for a novel study of modality on student learning, it is not without limitations. First, comparisons of learning (i.e. ASK scores) were collected approximately 18 months apart. The prior data collection of traditional in-seat and online students (2018) provided a comparison group for COVID-19 impacted students, however, and was ultimately the primary contributing factor to our successful receipt of NSF funding. The second is the relatively small sample size that limited the methodological freedom. Also, the sample comes from a single regional university in the Western United States and is racially homogeneous (i.e. high percentage of White/Caucasians). Fourth are the changes to the demographic make-up of courses. Primarily, the 2018 online section only had 5.6% first-year students, whereas the 2020 online section had 44.2% first-year students (Table 2). Unlike institutions located in countries that adhere to the Framework for Higher Education Qualifications (e.g. the United Kingdom), this disparity is possible in the United States because Human Geography is a general education course that can be taken at any time during a student's degree program. Fifth, due to the rapid collection of data in the midst of the COVID-19 pandemic, we were not able to use a pre-/post-test research design. And lastly, only learning about sustainability was evaluated. It would have been helpful to have surveyed students about their ERT experiences and also experience/preference for online and/or asynchronous course delivery. The rapid nature of IRB approval precluded this as an option, however.

Acknowledgements

This research was funded in part through the National Science Foundation (1951290, 1726278). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This research was funded in part through the National Science Foundation [1951290, 1726278].

References

Andrade, C. (2018). Internal, external, and ecological validity in research design, conduct, and evaluation. *Indian Journal of Psychological Medicine*, *40*(5), 498–499. https://doi.org/10.4103/IJPSYM.IJPSYM_334_18

Appana, S. (2008). A review of benefits and limitations of online learning in the context of the student, the instructor and the tenured faculty. *International Journal on E-Learning*, *7*(1), 5–22.

Arias, J. J., Swinton, J., & Anderson, K. (2018). Online vs. face-to-face: A comparison of student outcomes with random assignment. *E-Journal of Business Education and Scholarship of Teaching*, *12*(2), 1–23.

Castle, S., & McGuire, C. (2010). An analysis of student self-assessment of online, blended, and face-to-face learning environments: Implications for sustainable education delivery. *International Education Studies*, *3*(3), 36–40. https://doi.org/10.5539/ies.v3n3p36

Chevalier, R. D. (2011). When did ADDIE become addie? *Performance Improvement*, *50*(6), 10–14. https://doi.org/10.1002/pfi.20221

Chickering, A. W., & Gamson, Z. F. (1987). Seven principles for good practice in undergraduate education. *AAHE Bulletin*, *3*, 7.

Cohen, J. (1988). *Statistical power analysis for behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

Craig, C. A., Petrun Sayers, E. L., Gilbertz, S., Karam, R., & Feng, S. (2022). The role of STEM-based sustainability in business and management curricula: Exploring cognitive and affective outcomes in university students. *Journal of Management Education*, *46*(4), 656–684. https://doi.org/10.1177/10525629211056316

De de, C. (2022). The coming sea-change in teacher education. *Journal of Technology & Teacher Education*, *30*(2), 117–125.

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

Dvoráková, K., Emmer, J., Janktová, R., & Klementová, K. (2021). From F2F to ERT: University students' perception of remote learning during the first COVID-19 lockdown. *Journal on Efficiency and Responsibility in Education and Science*, *14*(2), 89–100. https://doi.org/10.7160/eriesj.2021.140203

Erdem-Aydin, İ. (2021). Investigation of higher education instructors' perspectives towards emergency remote teaching. *Educational Media International*, *58*(1), 78–98. https://doi.org/10.1080/09523987.2021.1908501

Gares, S. L., Kariuki, J. K., & Rempel, B. P. (2020). CommUnity matters: Student–instructor relationships foster student motivation and engagement in an emergency remote teaching environment. *Journal of Chemical Education*, *97*(9), 3332–3335. https://doi.org/10.1021/acs.jchemed.0c00635

Gelles, L. A., Lord, S. M., Hoople, G. D., Chen, D. A., & Mejia, J. A. (2020). Compassionate flexibility and self-discipline: Student adaptation to emergency remote teaching in an integrated engineering energy course during COVID-19. *Education Sciences*, *10*(11), 304. https://doi.org/10.3390/educsci10110304

Gilbertz, S., & Hall, D. (2022). *Bringing sustainability to the ground level: Competing demands in the Yellowstone River Valley*. Business Expert Express.

Graham, C., Cagiltay, K., Lim, B. R., Craner, J., & Duffy, T. M. (2001). Seven principles of effective teaching: A practical lens for evaluating online courses. *The Technology Source*, *30*(5), 50.

Hammerness, K., MacPherson, A., Gupta, P., Chafee, R., Anderson, K., Lagodich, L., & Abouelkheir, M. (2022). Missed opportunities in online learning. *Inside Higher Ed*, March 13.

Retrieved May 30, 2023, from https://www.insidehighered.com/views/2022/03/14/stem-students-struggled-online-learning-opinion .

Hassan, M. M., Mirza, T., & Hussain, M. W. (2020). A critical review by teachers on the online teaching-learning during COVID-19. *International Journal of Education and Management Engineering*, *10*(6), 17–27. https://doi.org/10.5815/ijeme.2020.05.03

Hein, W., Wilson, C., Lee, B., Rajapaksa, D., de Moel, H., Athukorala, W., & Managi, S. (2019). Climate change and natural disasters: Government mitigation activities and public property demand response. *Land Use Policy*, *82*, 436–443. https://doi.org/10.1016/j.landusepol.2018.12.026

Hodges, C. B., Moore, S., Lockee, B. B., Trust, T., & Bond, M. A. (2020). The difference between emergency remote teaching and online learning. Creative Commons BY-NC-ND 4.0 International License, Retrieved April 15, 2022, from http://hdl.handle.net/10919/104648.

Hussain, E. T., Daoud, S., Alrabaiah, H., & Owais, A. K. (2020). Student's perception of online assessment during the COVID-19 pandemic: The case of students in UAE. *2020 21st International Arab Conference on Information Technology (ACIT)*, 1–6. https://doi.org/10.1109/ACIT50332.2020.9300099

Johnson, G. M. (2015). On-campus and fully-online university students: Comparing demographics, digital technology use and learning characteristics. *Journal of University Teaching & Learning Practice*, *12*(1), 45–58. https://doi.org/10.53761/1.12.1.4

Johnson, N., Veletsianos, G., & Seaman, J. (2020). U.S. Faculty and administrators' experiences and approaches in the early weeks of the COVID-19 pandemic. *Online Learning*, *24*(2), 6–21. https://doi.org/10.24059/olj.v24i2.2285

Khan, A., Egbue, O., Palkie, B., & Madden, J. (2017). Active learning: Engaging students to maximize learning in an online course. *Electronic Journal of E-Learning*, *15*(2), 107–115.

Khlaif, Z. N., Salha, S., & Kouraichi, B. (2021). Emergency remote learning during COVID-19 crisis: Students' engagement. *Education and Information Technologies*, *26*(6), 7033–7055. https://doi.org/10.1007/s10639-021-10566-4

Kimble-Hill, A. C., Rivera-Figueroa, A., Chan, B. C., Lawal, W. A., Gonzalez, S., Adams, M. R., Heard, G. L., Gazley, J. L., & Fiore-Walker, B. (2020). Insights gained into marginalized students access challenges during the COVID-19 academic response. *Journal of Chemical Education*, *97*(9), 3391–3395. https://doi.org/10.1021/acs.jchemed.0c00774

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory into Practice*, *41*(4), 212–218. https://doi.org/10.1207/s15430421tip4104_2

Li, Y., Krause, S., McLendon, A., & Jo, I. (2023). Teaching a geography field methods course amid the COVID-19 pandemic: Reflections and lessons learned. *Journal of Geography in Higher Education*, *47*(2), 339–348. https://doi.org/10.1080/03098265.2022.2041571

Lockee, B. B. (2021). Online education in the post-COVID era. *Nature Electronics*, *4*(1), 5–6. https://doi.org/10.1038/s41928-020-00534-0

Maciejewski, M. L. (2020). Quasi-experimental design. *Biostatistics & Epidemiology*, *4*(1), 38–47. https://doi.org/10.1080/24709360.2018.1477468

McMurtrie, B. (2022, April 2). A 'Stunning' Level of Student Disconnection. *The Chronicle of Higher Education*. Retrieved May 24, 2023, from https://www.chronicle.com/article/a-stunning-level-of-student-disconnection

National Center for Education Statistics (NCES). (2020). Fast Facts: Distant. *United States Department of Education*. Retrieved April 8, 2021, from https://nces.ed.gov/fastfacts/display.asp?id=372#College_enrollment.

Petrun Sayers, E. L., Craig, C. A., Gilbertz, S., Feng, S., Karam, R., & Bohman, A. (2020). Advancing STEM-based business sustainability: Mending the curricular gap. *Management Teaching Review*, *5*(1), 82–93. https://doi.org/10.1177/2379298119852313

Petrun Sayers, E. L., Craig, C. A., Skonicki, E., Gahlon, G., Gilbertz, S., & Feng, S. (2021). Evaluating STEM-based sustainability understanding: A cognitive mapping approach. *Sustainability*, *13*(14), 8074. https://doi.org/10.3390/su13148074

Schultz, R. B., & DeMers, M. N. (2020). Transitioning from emergency remote learning to deep online learning experiences in geography education. *Journal of Geography*, *119*(5), 142–146. https://doi.org/10.1080/00221341.2020.1813791

Shin, M., & Hickey, K. (2021). Needs a little TLC: Examining college students' emergency remote teaching and learning experiences during COVID-19. *Journal of Further and Higher Education*, *45*(7), 973–986. https://doi.org/10.1080/0309877X.2020.1847261

Sullivan, G. M., & Feinn, R. (2012). Using effect size—or why the P value is not enough. *Journal of Graduate Medical Education*, *4*(3), 279–282. https://doi.org/10.4300/JGME-D-12-00156.1

Thomas, M., & Bryson, J. R. (2021). Combining proximate with online learning in real-time: Ambidextrous teaching and pathways towards inclusion during COVID-19 restrictions and beyond. *Journal of Geography in Higher Education*, *45*(3), 446–464. https://doi.org/10.1080/03098265.2021.1900085

Trust, T., & Whalen, J. (2020). Should teachers be trained in emergency remote teaching? Lessons learned from the COVID-19 pandemic. *Journal of Technology & Teacher Education*, *28*(2), 189–199. https://www.learntechlib.org/primary/p/215995/

Varachotisate, P., Siritaweechai, N., Kositanurit, W., Thanprasertsuk, S., Chayanupatkul, M., Thongsricome, T., Bumphenkiatikul, T., Chuleerarux, N., Watanatada, P., Werawatganon, D., Somboonwong, J., Siriviriyakul, P., Sanguanrungsirikul, S., Bongsebandhu-Phubhakdi, S., Ratanasirisawad, V., Jaroenlapnopparat, A., Burana, C., Somsirivattana, P., Kulaputana, O., & Kaikaew, K. (2023). Student academic performance in non-lecture physiology topics following the abrupt change from traditional on-site teaching to online teaching during COVID-19 pandemic. *Medical Education Online*, *28*(1), 2149292. https://doi.org/10.1080/10872981.2022.2149292

Wahab, A. (2020). Online and remote learning in higher education institutes: A necessity in light of COVID-19 pandemic. *Higher Education Studies*, *10*(3), 16–25. https://doi.org/10.5539/hes.v10n3p16

West, H., Hill, J., Abzhaparova, A., Cox, W., & Alexander, A. (2023). Pandemic pedagogies: Reflecting on online learning using the community of inquiry framework. *Journal of Geography in Higher Education*, 1–20. https://doi.org/10.1080/03098265.2023.2190962

Wilhelm, J., Mattingly, S., & Gonzalez, V. H. (2022). Perceptions, satisfactions, and performance of undergraduate students during Covid-19 emergency remote teaching. *Anatomical Sciences Education*, *15*(1), 42–56. https://doi.org/10.1002/ase.2161

Winter, E., Costello, A., O'Brien, M., & Hickey, G. (2021). Teachers' use of technology and the impact of covid-19. *Irish Educational Studies*, *40*(2), 235–246. https://doi.org/10.1080/03323315.2021.1916559

Zwickle, A., Koontz, T. M., Slagle, K. M., & Bruskotter, J. T. (2014). Assessing sustainability knowledge of a student population: Developing a tool to measure knowledge in the environmental, economic and social domains. *International Journal of Sustainability in Higher Education*, *15*(4), 375–389. https://doi.org/10.1108/IJSHE-01-2013-0008