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Integrating and evaluating interdisciplinary sustainability and STEM curriculum in geographical education: A case of three teaching modalities

Susan Gilbertz
Montana State University - Billings, sgilbertz@msubillings.edu

Brittany Wood
Murray State University, bwood4@murraystate.edu

Christopher Craig
Murray State University, ccraig8@murraystate.edu

Ismail Karabas
Murray State University, ikarabas@murraystate.edu

Elizabeth Petrun Sayers
Johns Hopkins University

See next page for additional authors

Authors
Susan Gilbertz, Brittany Wood, Christopher Craig, Ismail Karabas, Elizabeth Petrun Sayers, and Benjamin McCormick

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Gilbertz, S.J.[a], B. Woods[b], C.A. Craig[c]*, I. Karabas [c], E.L. Petrun Sayers[d] and B. McCormick[c]

[a]*Social Sciences & Cultural Studies Department, Montana State University Billings, Billings, Montana, United States;* [b]*Department of Political Science and Sociology, Murray State University, Murray, Kentucky, United States;* [c]*Management, Marketing, and Business Administration Department, Murray State University, Murray, Kentucky, United States;* [d]*RAND Corporation, Arlington, VA, United States*

*C.A. Craig, College of Business, Murray State University, Murray, Kentucky, United States, 42071, christopheralancraig@gmail.com

Dr. Susan J. Gilbertz, Professor of Geography, teaches geography and environmental studies courses at Montana State University Billings. She also serves as the Acting Associate Dean of the College of Business. She earned her PhD from Texas A&M University in 2002. Her research focuses on the intersections where sense of place, water resources, policy development and sustainability concerns overlap. Much of her work is uses the Yellowstone River Valley as her region of focus.

Dr. Brittany Wood is an Assistant Professor of Political Science in the Department of Political Science and Sociology within the College of Fine Arts and Humanities at Murray State University. Brittany's research interests lie in comparative politics, international relations, and political psychology. Specifically, her research agenda focuses on the international experiences of citizens and how these experiences influence their domestic political behavior, views of democratic institutions, and foreign policy opinions. Brittany teaches courses in comparative politics and research methods.

Dr. Christopher A. Craig is an Assistant Professor of Management in the Department of Management, Marketing, and B.A. within the Arthur J. Bauernfeind College of Business at Murray State University . He also serves as an Associate Editor for the CASE Journal. Dr. Craig currently teaches applied organizational sustainability, managing sustainability, outdoor tourism management, and strategic management courses. Dr. Craig’s research interests include management and STEM education, strategic management, outdoor tourism, climate change, and human-natural environment interactions.

Dr. Ismail Karabas is an Assistant Professor of Marketing in the Department of Management, Marketing, and B.A. within the Arthur J. Bauernfeind College of Business at Murray State University. Ismail’s research focuses on services marketing and advertising, and he published several articles in peer-review journals. Ismail teaches principles of marketing and integrated marketing communications and the graduate level marketing planning and application class.

Dr. Elizabeth L. Petrun Sayers' areas of expertise include science (risk, health, environment), strategic, and organizational communication. Her research applies core concepts from the communication discipline to understand how information, technology, and media impact outcomes spanning knowledge, attitudes, and behaviors across audiences. Petrun Sayers is a Full Behavioral and Social Scientist with the RAND Corporation in Arlington, VA.

Benjamin McCormick is an undergraduate economics major at Murray State University and a Presidential Fellow. Benjamin is conducting honors research on the effects of COVID-19 on student experiences and learning.

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Integrating and evaluating interdisciplinary sustainability and STEM curriculum in geographical education: A case of three teaching modalities

The effectiveness of interdisciplinary sustainability curriculum remains understudied in geography education. Accordingly, we deployed and evaluated an interdisciplinary sustainability and STEM module for in-person and online sections of a fall 2018 Human Geography course. Results indicate that sustainability knowledge improved after the interdisciplinary curricular intervention irrespective of course modality. Another focus is to explore student reactions to teaching modality due to COVID-19 disruptions. Results indicate that online student sustainability knowledge also improved during COVID-19 (fall 2020). For students in a section converted from in-person to blended, sustainability knowledge did not improve. Implications are provided.

Keywords: geography education; sustainability; STEM; evaluation; emergency remote teaching (ERT)

Introduction

Sustainability agendas focus on creating “conditions under which humans and nature can exist in productive harmony to support present and future generations” (Environmental Protection Agency [EPA] 2021, III). This makes geography educators, with backgrounds in multiple physical and cultural subdisciplines, and who are now housed in many differently-named departments (Frazier and Wikle 2017), uniquely positioned to play a central role in preparing students to participate in disciplinary-spanning sustainability initiatives (Meadows 2020; Liu 2010). However, such interdisciplinary sustainability curriculum remains understudied by geography education researchers. To address this research gap, we designed, developed, implemented, and evaluated a multi-week interdisciplinary sustainability module for in-person and online sections of Human Geography at a regional university in the Western United States.

We targeted the course Human Geography for implementation because it helped us avoid the tendency to disproportionately cover environmental sustainability topics (Yli-Panula, Joronen and Lemmetty 2020). It also forced us to design some reconciliations between scientific methods and social theories. Further, as noted by Kaplan (2021), geography education should address dynamics that have perhaps contributed to its "marginality." This project does so via two foci: (1) infusing immediate relevance into the Human Geography curriculum, and (2) by helping all educators anticipate the impacts of emerging learning environments.

Regarding the first focus area, we designed a course module to explicitly connect human dimensions of sustainability with sustainability content illuminated via Science, Technology, Engineering and Math (STEM). In doing so, the new course content directly serves the growing importance of interdisciplinary STEM education (Li et al 2020, Li 2018, Widener et al. 2016, Liu 2010). The module also addressed other calls for curricular reform: (1) generate understandings of "the real world" (International Bureau of Education 2021, I); (2) deploy regionally or place-based pedagogies (Hooykaas 2021; Israell 2012); (3) encourage geography students to interact with content critically (Walshe 2016); (4) invest successful implementation of interdisciplinary curriculum (Craig et al. 2021; Kurland et al. 2010; Petrun Sayers et al. 2021; Smith and Watson 2019); and (5) investigate the results of interdisciplinary curricular efforts (Bednarz 2000; Downs 1994). By building the module to incorporate these varied elements, the project illustrates how a sustainability module can help engender geography education with immediate relevance to local communities and to the career paths of the students.

A second focus emerged because of COVID-19. Our sustainability module was first implemented and evaluated in fall 2018 as part of a National Science Foundation (NSF) project, and we anticipated gathering additional data over ensuing semesters. Out of necessity, our goals evolved into a natural research design, where the experimental condition was the curricular intervention during COVID-19 (fall 2020) and the control condition was the curricular intervention prior to COVID-19 (fall 2018). Like others working to document the impacts of

COVID-19 on pedagogies and learning (Day et al. 2021; Schultz and Demers 2020), we evaluated the effectiveness of interrupted course modalities. We used pre- and post-tests to investigate the impact of curriculum on student sustainability knowledge, a cognitive indicator of performance improvement, and we explored the effects of emergency remote teaching (ERT) on undergraduate experiences with our newly launched interdisciplinary curriculum. ERT differs from legacy online or blended education because it abruptly occurs as a result of a crisis, not student preference or administrative objectives (e.g., increased enrollments) (Hodges, Moore and Lockee 2020). It takes little imagination to think that ERT situations will arise again, perhaps sooner than we imagine. Thus, the data and conclusions from the second focus of our project are instructive in terms of positioning educators to be prepared for ERT situations.

Below, we overview our interdisciplinary curriculum, introduce the sustainability outcomes used for evaluation, and review the impact of COVID-19 on modalities. Next, we present methods, results, discussion, and offer conclusions.

Sustainability and STEM curricular intervention

Our interdisciplinary sustainability curricular intervention (henceforth called “curricular intervention”) was a multi-week interdisciplinary STEM-based module anchored by an original case study. The purpose of integrating STEM into the curriculum is two-fold. First, there is an increasing demand for STEM educated graduates. For instance, Borrego and Henderson (2014) note that prominent organizations are expressing the need for a larger pool of STEM trained graduates. Likewise, the U.S. Department of Education (DoEd; 2021a) highlights the need for STEM fluency among undergraduate students entering the workforce to address current and future complex challenges, including sustainability challenges. Second, STEM education benefits undergraduate students by preparing them to succeed in the workforce. In addition to ample employment opportunities based on market demand, STEM educated graduates can also expect higher wages compared to graduates from other disciplines. Carnevale, Cheah and Hansen (2015) report that entry-level STEM graduates earn 23% more when compared to all other majors combined.

The curricular intervention at the heart of this study involves an integrative and interdisciplinary case study that utilizes a regional and place-based geographic context to highlight the coupling of human and natural systems. The Gilbertz and Hall (2022) case study book (i.e., the focal resource and anchor of the module) requires students to apply STEM knowledge and skills to some of the most environmentally, socially, and economically salient sustainability problems along the iconic Yellowstone River Valley in Montana, United States. Concrete examples of STEM application from Gilbertz and Hall (2022) include (but are not limited to): (S) climate science and bio-diversity, (T) data visualization, (E) geological engineering, and (M) empirical analyses. Consistent with best practices, the case study is active, problem-based, and examines practical concerns (Hopkinson and James 2010). The sections of the multi-week module correspond with the first five chapters of the Gilbertz and Hall (2022) case study book. To provide additional context, Table 1 lists the module learning objectives and case study chapters.

[Insert Table 1 about here]

The curricular intervention was initially implemented and evaluated in a live, in-person section along with an asynchronous online section of Human Geography in fall 2018. Human Geography is an unrestricted general elective available to all students at the regional university in the Western United States. For the fall 2018 iteration of the intervention, we evaluated students using a pre- and post-test design to assess sustainability knowledge before and after the curricular intervention.

Sustainability knowledge

Sustainability knowledge is an individuals' understanding about sustainability, its components, and the interconnectedness of the components (Petrun Sayers et al. 2020) and our focal outcome. According to Heeren et al. (2016, 615), "attention to sustainability knowledge is evident in the growth of [higher] education curricula." We adopted the Sustainability Knowledge Assessment (ASK; Zwickle et al. 2014) to longitudinally assess sustainability knowledge change (i.e., cognitive learning). The instrument was originally designed, developed, and validated by an interdisciplinary research team at a large Carnegie Research 1 designated school. Further, the measure has been utilized at multiple institutions to document yearly university-wide sustainability knowledge (Heeren et al. 2016; Zwickle et al. 2014). The original ASK contained 16 multiple choice questions, including six environmental, five social, and five economic. Consistent with the updated ASK scale (Zwickle and Jones 2018), a single economic question was removed because it was no longer accurate (see Table 2 to view the ASK instrument).

[Insert Table 2 about here]

To-date, higher education studies about sustainability-related knowledge have primarily been cross-sectional, and thus have not included pre- and post-tests for educational interventions (e.g., Ajzen et al. 2011; Heeren et al. 2016; Whitley et al. 2018). Zwickle and Jones (2018) called on researchers to introduce more robust research designs that include both pre- and post-tests in interventions. Here, we explore sustainability knowledge before and after exposure to the curricular intervention. The design addresses a salient research gap in geography education lacking longitudinal studies (Zadrozny et al. 2016), a criticism also shared by sustainability and

STEM education more broadly (Petrun Sayers et al. 2020). To assess the impact of curriculum on student sustainability knowledge, we ask:

Research Question 1: Did student ASK scores improve after receiving the curricular intervention?

COVID-19 impact

The COVID-19 pandemic created life-altering changes that students, university leadership, educators, and broader society continue to face. When the COVID-19 outbreak escalated in March 2020, it was unclear how universities needed to respond and how far-reaching the impacts could be for students. Realizing the likelihood of adverse effects to student learning, the director of the NSF Division of Undergraduate Education solicited proposals from investigators on active projects to study the effects of COVID-19 on STEM-related educational outcomes. While our project was slated to conclude in summer 2020, it was ultimately extended and supported with additional funding to study the effects of COVID-19 on student experiences. This extension permitted exploration of the curricular intervention before and during COVID-19 along with the course modality (i.e., in-person, online, blended).

The curricular intervention was implemented in all sections of Human Geography following the initial fall 2018 deployment, although courses were not evaluated again until fall 2020. During the fall 2020 term, the in-person section of Human Geography became blended due to COVID-19 restrictions. The 15-week fall 2020 term for the blended section included three weeks of traditional live in-seat instruction and a three-week online group project. The course was originally scheduled to include two more weeks of live in-person instruction, but instead, transitioned ahead-of-schedule to pre-recorded lectures posted weekly to a Learning Management System (LMS) for the duration of the term. The lectures were posted to the LMS in time for students to use their "normal (geography) class hours" as times for accessing the recorded materials. The curricular intervention was implemented during the latter portion of the term via the pre-recorded lectures and content posted to the LMS. There were no changes to implementation of the asynchronous online section fall 2020 as a result of COVID-19.

COVID-19 and modalities

Live in-person courses are the traditional learning format at most postsecondary institutions. In 2019, prior to the pandemic, nearly 63% of postsecondary students filled their course schedules with only in-person courses (National Center for Education Statistics [NCES] 2020). Online asynchronous courses present materials virtually using a LMS. Although not as common as in-person instruction, online course offerings have substantially expanded over the last two decades (Ragusa and Crampton 2017). For comparison, approximately 20% of postsecondary students enrolled in at least one online course in addition to their in-person courses in 2019, while 18% of total postsecondary students enrolled in online courses only (NCES 2020). Blended courses (i.e., hybrid) integrate synchronous meetings (either virtual or in-person) with asynchronous digital instruction. The number of courses utilizing a blended modality prior to the pandemic is unclear; however, post-COVID-19, postsecondary institutions around the world introduced more online and blended course opportunities.

Extant research on learning outcomes among students of in-person, online, and blended courses is mixed. This is because each modality has unique attributes that benefit certain types of cognitive processes and social interactions (Kozma 1994; Larson and Sung 2009; Pentina and Neeley 2007; Tang and Byrne 2007). In-person synchronous courses offer opportunities for students to engage in real-time discussions with their instructor and peers in a setting that is designed to minimize distractions. Asynchronous online courses, on the other hand, allow students to engage and participate in the course at their own pace and at flexible times (according to the guidelines set by the instructor), making this modality advantageous to non-traditional and working students (Ragusa and Crampton 2017).

Modalities also influence student learning experiences. According to Khan et al. (2017), active learning, or the purposeful engagement with the curriculum being taught, is possible via a synchronous in-person modality but is more difficult in an asynchronous online setting. Consequently, when asynchronous delivery is required, combining synchronous touch-points with asynchronous elements in a blended format may improve the student experience (Dumford and Miller 2018). A meta-analysis of over 50 studies found that students enrolled in blended courses performed better than both those in purely online and in-person courses (Means et al. 2010). Interestingly, this same study also found that online courses outperformed in-person courses regarding student learning outcomes.

The mixed conclusions regarding learning modalities could be explained by several factors. First, many studies do not incorporate rigorous standards of comparison in their research designs such as holding more than one aspect of instruction (e.g., time to complete an activity, instructor, availability to re-watch lecture, type of assignments, etc.) the same across all conditions (Means et al. 2010). Further, few studies have compared in-person, online, and blended modalities, instead focusing only on two of the three modalities. Perhaps more importantly, most studies allowed self-selection to determine modality groups (Farros et al. 2020). The conditions of the pandemic presented a unique opportunity to study the impact of course modalities given that many students were compelled to join online or blended courses when they would have otherwise opted for in-person instruction. To assess the impact of course modality on student outcomes, we ask:

Research Question 2a: Did student ASK scores improve after receiving the curricular intervention during COVID?

Research Question 2b: How did student ASK scores compare for online and blended students during COVID-19?

Research Question 2c: How did student ASK scores during COVID-19 compare to those prior to COVID?

Methods

Surveys were administered using Qualtrics to collect data from students participating in the curriculum. During the fall 2018 and 2020 terms, students participated in a survey before and after the curricular intervention. We informed students that they would receive two extra credit points if they participated in both the pre- and post-tests. Additionally, we offered students the option to complete an alternative assignment to earn the extra points if they decided not to participate in the pre- and post-tests. For both the pre- and post-tests, the Human Geography instructor emailed students survey links and posted the link to an LMS. Prior to either survey being administered, Institutional Review Board (IRB) approval was obtained. In total, 82 students completed pre- and post-tests (n=164). The pre- and post- tests assessed sustainability knowledge using the ASK (Zwickle et al. 2014) (see Table 2). Student demographics sorted by modality and term are provided in Table 3.

[Insert Table 3 about here]

Statistical analysis

We used two statistical methods to test *Research Questions 1* and *2a-c*. For *Research Question 1* and *2a*, we ran paired sample t-tests to assess changes in student knowledge (i.e., ASK) from pre- to post-tests, or before and after the curricular intervention for each of the modalities. Outputs from the analysis include paired sample statistics, paired sample correlations, and paired sample t-tests (see Tables 4 and 5). Significant paired sample correlations (Table 4) for the majority of pairs provides support for using paired sample t-tests methodology (Reichardt 1979). For *Research Questions 2b* and *2c*, we ran independent sample t-tests to determine if there were significant differences on the ASK at the course-level comparing (1) online and blended student pre- and post-tests fall 2020, (2) in-person (fall 2018) and blended (fall 2020) student pre- and post-tests, and (3) online pre- and post-tests fall 2018 and fall 2020.

[Insert Tables 4 and 5 about here]

Results

Research Question 1 asks if student sustainability knowledge (i.e., ASK) will improve after receiving the curricular intervention. Results from paired sample t-tests indicate there was significant improvement at the $p<.01$ level on the ASK for fall 2018 in-person students ($t(20)=-5.51$, $p=.000$, *pre-test*=56%, *post-test*=78%) and online students ($t(17)=-4.71$, $p=.000$, *pre-test*=45%, *post-test*=65%). The results indicate that both in-person and online modalities demonstrated improvement after receiving the curricular intervention.

Research Question 2a asks how students would respond to the curricular intervention during COVID-19. To assess this question, we utilized paired-sample tests for blended and online students fall 2020. Results from the paired sample-tests for blended students indicate there was no significant improvement after receiving the intervention ($t(12)=-1.82$, $p=.097$, *pre-test*=48%, *post-test*=56%) (see Table 5). Comparable to fall 2018 prior to COVID-19, we observed significant improvement for online students fall 2020 during COVID-19 ($t(30)=-4.43$, $p=.000$, *pre-test*=60%, *post-test*=74%). *Research Question 2b* asks how ASK scores for blended and online students compared during COVID-19. Results from independent sample t-tests indicate that there were no differences between blended and online students at the $p<.01$ level on for ASK pre-tests (*t*(29.52)=2.13, *p*=.042, *online pre-test*=60%, *blended pre-test*=48%) but online students scored significantly higher than blended students on the post-tests (*t*(33.48)=3.58, *p*=.001, *online post-test*=74%, *blended post-test*=56%).

[Insert Table 6 about here]

Research Question 2c asks how ASK scores during COVID-19 (fall 2020) compared to ASK scores prior to COVID-19 (fall 2018). To assess this question, we ran a series of independent sample t-tests comparing (1) in-person students (fall 2018) to blended students (fall 2020) and (2) online students before (fall 2018) and during COVID-19 (fall 2020). There were no significant changes for in-person/blended pre-tests from fall 2018 to 2020 (*t*(29.57)=1.27, *p*=.214) though there was a significant change on post-tests for the ASK (*t*(30.99)=3.82, *p*=.001) (see Table 6). The positive mean difference in Table 6 is an indication that scores were significantly higher for in-person students fall 2018 than for blended students fall 2020 on post-tests. For online students, there were no significant differences at the p<.01 level for pre-tests (*t*(37.56)=-2.57, *p*=.014, *fall 2018 pre-test*=45%, *fall 2020 pre-test*=60%) or post-tests (*t*(37.72)=-1.48, *p*=.148, *fall 2018 post-test*=65%, *fall 2020 post-test*=74%) from fall 2018 to 2020 for the ASK. See Figure 1 for a graphic description of live and online scores from the fall 2018 to fall 2020 term.

[Insert Table 6 and Figure 1 about here]

We opted to run post-hoc analysis to determine if any of the reported demographic factors (see Table 3) were significantly related to ASK scores. Using univariate analysis of variance (ANOVA) we sorted by modality (i.e., in-person/blended and online) and test (i.e., pre-test and post-test) where (1) ASK was the dependent variable, (2) year was the independent variable, and (3) demographics were covariates. No demographic covariates emerged as significant.

Discussion

In sum, our findings show how a revised curriculum can meet calls from business leaders and government agencies to improve the sustainability and STEM literacy of the future workforce (Bagley et al. 2020; DoEd 2021a). The project also addresses concerns that curricular innovations are not followed with robust evaluations (Zadrozny et al. 2016). Our pre- and post-test research design provided strong evidence of the effectiveness of the curricular intervention on student learning, irrespective of course modality. These findings suggest that integrating a sustainability focused curricular intervention in geography education is an effective way to improve student knowledge on the topic of sustainability using either a synchronous or asynchronous mode of delivery. Geography remains particularly well-positioned to deploy interdisciplinary sustainability and STEM education because "it reaches across all sciences (including social sciences and humanities)" (Meadows et al. 2020, p. 88).

At the directive of the NSF, the secondary aim of this study was to assess the impact of COVID-19 on undergraduate student learning. We implemented and evaluated the same curricular intervention in blended and online sections of Human Geography during the COVID-19 pandemic. Using the same research design, we found that sustainability knowledge significantly improved for online students, but not for students in the blended section (fall 2020) as compared to in-person students (fall 2018). Further, we observed a significant course-level decline in sustainability knowledge on post-tests comparing in-person and blended students from fall 2018 to 2020, but found no significant difference between online students from the same time period.

Results from *Research Question 2* are inconsistent with the Means et al. (2010) meta-analysis, that blended courses outperformed in-person and online modalities. Hodges et al. (2020) contend that a potential reason for the disparity is that the blended Human Geography course is considered an ERT course (i.e., a course that required impromptu changes due to the COVID-19 crisis). In contrast to ERT, traditional legacy courses can be designed and developed to promote student retention, participation, and engagement (Hodges et al. 2020). Furthermore, COVID-19 introduced other challenges to teaching and learning. For instance, nearly all post-secondary students struggled with at least one aspect of their mental health and well-being during the pandemic (DoEd 2021b). In-person instruction exasperated these effects for some students. Given that some students perform better in online courses than others, it is also possible that the compelled nature of the course modality change, including an online group assignment and pre-recorded lectures rather than synchronous in-person lectures, did not suit students' preferred learning styles.

Limitations and future research

Given the exploratory nature of this work and small sample size (a limitation) across the four conditions, future work should aim for larger sample sizes across conditions when implementing the pre- and post-test research design. Future researchers should also strive to utilize treatment and control groups. Due to the uniqueness of ERT instructor responses to COVID-19, we were unable to identify and collect data from a control cohort of students. Replicability of this study is possible for future educators and researchers who (1) utilize the focal teaching resource (Gilbertz and Hall 2022), (2) adapt comparable learning objectives (see Table 1), (3) evaluate holistic sustainability learning using previously validated instruments (e.g., Table 2), and (4) deploy a robust research design comparable to that described in the methods section.

Future researchers may want to consider the suite of instruments used to assess sustainability knowledge. For instance, the original ASK (Zwickle et al., 2014) was recently updated to a 12-question short-version of the instrument that is more closely correlated with sustainability knowledge overall than the previous scale (Zwickle and Jones 2018). A short-coming of both ASK instruments is the use of close-ended questions, making it unlikely for students to improve on questions that are not covered as part of the curriculum. The use of qualitative methods such as focus groups and interviews alongside quantitative methods can help overcome this limitation and gain a clearer picture of student understanding of sustainability, not just their levels of sustainability knowledge

Another study limitation is that we did not randomly assign students into modality conditions. As an ideal research model, we might encourage other scholars on this topic to assign students to modality conditions randomly, rather than via self-selection. However, this suggestion will generate little traction in institutions where efforts are made to meet students' modality preferences. The unexpected nature of crises and disasters further complicates random assignment. Looking forward, anecdotal evidence suggests that nearly every college student (and instructor) has now experienced either ERT or online modalities. Considering, ERTs may have lost much of their jarring and disruptive impacts. Future research should explore the extent to which previous ERT experiences moderate the negative impacts of ERT deployment.

Finally, we implemented and evaluated the curricular intervention at a regional institution in the Western United States, where the case study was particularly relevant and salient. While it is easy to ask students to apply the tenants of the case to their own communities, future studies should consider implementing curriculum more broadly using a comparably robust evaluation design, including higher-education institutions throughout the United States, internationally, and in different types of institutions (e.g., community or tribal colleges, Carnegie Research 1 designated schools).

Conclusion

The purpose of the study was two-fold: (1) to deploy and evaluate an innovative interdisciplinary sustainability and STEM geography curriculum module, and (2) to assess the impact of course disruptions, across modalities (i.e., in-person, online, blended). Results provide initial evidence that incorporating sustainability modules into geography curriculum is valuable and effective means of preparing students to help build a world where “humans and nature can exist in productive harmony to support present and future generations” (Environmental Protection Agency [EPA] 2021, III). The results also suggest that online courses can continue to produce high learning outcomes even when teaching modalities are wholly interrupted or wholly upended. There is no doubt that the pandemic has taken a toll on students and faculty. If there is a silver lining to our findings, it is that technological advancements have made education possible during a crisis that would have otherwise led to much greater teaching and learning disruptions.

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Tables and Figures

Table 1. Module learning objectives and Gilbertz and Hall (2022) case study chapters.

Module Learning Objectives	1. Define, explain, and apply the economic, environmental, and social components of sustainability using STEM-based evidence; 2. Define and explain sustainability as three components; 3. Discuss sustainability as a useful framework for addressing current and future needs of community; and 4. Identify and critically evaluate the details of the Gilbertz and Hall (2022) case study.
Gilbertz and Hall (2022) Chapters	1. Sustainability and the Yellowstone River 2. Economic Wellbeing in the Yellowstone River Valley 3. Environmental Wellbeing in the Yellowstone River Valley 4. Social Wellbeing in the Yellowstone River Valley 5. Sustainability's Complexities 6. Progress of Sustainability and Sustainability as Progress

Table 2. Sustainability Knowledge Assessment (ASK; from Zwickle et al., 2014).

Question Root	**Category**	**Correct Answer**
What is the most common cause of pollution of streams and rivers?	Environmental	Surface water running off yards, city streets, paved lots and farm fields
Ozone forms a protective layer in the earth's upper atmosphere. What does ozone protect us from?	Environmental	Harmful UV rays
What is the name of the primary federal agency that oversees environmental regulation?	Environmental	Environmental Protection Agency (the EPA)
What is the primary benefit of wetlands?	Environmental	Clean the water before it enters lakes, streams, rivers or oceans
Which of the following is an example of sustainable forest management?	Environmental	Never harvesting more than what the forest produces in new growth
In the USA, what do we currently do with the nuclear waste generated by nuclear power plants?	Environmental	Store and monitor the waste
Which of the following is the most commonly used definition of sustainable development?	Social	Meeting the needs of the present without compromising the ability of future generations to meet their own needs
The wealthiest 20 % of people in the USA own approximately what percent of the nation's privately held wealth?	Social	85%
Over the past three decades, what has happened to the difference between the wealth of the richest and poorest Americans?	Social	The difference has increased
Higher levels of education generally lead to [. . .]	Social	Greater annual earnings
Which of the following populations has the highest rate of growth?	Social	Africa
Which of the following countries has now passed the USA as the biggest emitter of the greenhouse gas carbon dioxide?	Economic	China
Many economists argue that electricity prices in the USA are too low because [. . .]	Economic	They do not reflect the costs of pollution from generating the electricity
Which of the following is a leading cause of the depletion of fish stocks in the Atlantic Ocean?	Economic	Fishermen seeking to maximize their catch
Which of the following is the most commonly used definition of economic sustainability?	Economic	Long-term profitability

Note. The 15-item ASK scale has a Cronbach's alpha of .78. The question root of the removed questions is "Which of the following is the primary reason that gasoline prices have risen over the past several decades in the USA?"

Table 3. Demographics.

	Live fall 2018 (N=21)	**Blended fall 2020 (N=12)**	**Online fall 2018 (N=18)**	**Online fall 2020 (N=31)**
Gender	47.6% Male, 52.4% Female	16.7% Male, 83.3% Female	27.8% Male, 72.2% Female	29.0% Male, 71.0% Female
Age	Mean=20.62 (range 18-32)	Mean=19.42 (range 18-24)	Mean=21.83 (range 19-34)	Mean=26.42 (range 18-55)
Race	95.2% White, 4.8% American Indian or Alaskan Native	75.0% White, 25.0% American Indian or Alaska Native	88.9% White, 11.1% American Indian or Alaska Native	83.9% White, 6.5% Black or African American, 3.2% American Indian or Alaska Native, 6.5% Native Hawaiian or Other Pacific Island
Ethnicity	0% Latinx, Hispanic, or Spanish speaking background	16.7% Latinx, Hispanic, or Spanish speaking background	5.6% Latinx, Hispanic, or Spanish speaking background	0% Latinx, Hispanic, or Spanish speaking background
Party	42.9% Republican, 28.6% Independent, 9.5% Democrat, 9.5% Libertarian, 9.5% Other	58.3% Republican, 16.7% Democrat, 16.7% Libertarian, 8.3% Other	22.2% Republican, 33.3% Independent, 22.2% Democrat, 22.2% Other	45.2% Republican, 25.8% Independent, 6.5% Democrat, 22.6% Other
Grade	38.1% Freshman, 23.8% Sophomore, 33.3% Junior, 24.2%, 4.8% Graduate	50.0% Freshman, 25.0% Sophomore, 25.0% Junior	5.6% Freshman, 55.6% Sophomore, 22.2% Junior	35.5% Freshman, 16.1% Sophomore, 22.6% Junior, 16.1% Senior, 9.7% Graduate
Employment	4.8% Full-Time, 52.5% Part-Time, 42.9% Not Employed	16.7% Full-Time, 50.0% Part-Time, 33.3% Not Employed	33.3% Full-Time, 44.4% Part-Time, 22.2% Not Employed	45.2% Full-Time, 45.2% Part-Time, 9.7% Not Employed

Note. On the fall 2020 post-test, one student identified as Other for gender that identified as Male on the pre-test.

Table 4. Paired sample statistics and correlations for ASK scores.

	Test	***M***	***N***	***SD***	***SE***	***R***	***p***
In-person fall 2018	Pre	0.56	21	0.21	0.05	0.56	0.009
	Post	0.78	21	0.21	0.05		
Blended fall 2020	Pre	0.48	12	0.15	0.04	0.48	0.114
	Post	0.56	12	0.12	0.04		
Online fall 2018	Pre	0.45	18	0.20	0.05	0.56	0.016
	Post	0.65	18	0.19	0.04		
Online fall 2020	Pre	0.60	31	0.21	0.04	0.68	0.000
	Post	0.74	31	0.20	0.04		

Table 5. Paired sample t-tests for ASK pre- and post-tests.

	N	*M diff.*	*SD*	*SE*	*95% CI*		*t*	*df*	*p*
					Lower	**Upper**			
In-person fall 2018	21	-0.22	0.20	0.04	-0.31	-0.13	-5.01	20	0.000
Blended fall 2020	12	-0.07	0.14	0.04	-0.16	0.02	-1.82	11	0.097
Online fall 2018	18	-0.20	0.18	0.04	-0.30	-0.11	-4.71	17	0.000
Online fall 2020	31	-0.13	0.17	0.03	-0.19	-0.07	-4.43	30	0.000

Table 6. Independent sample t-tests for ASK.

	F	*p*	*t*	*df*	*p*	*M diff.*	*SE diff.*	*95% CI*	
								Lower	**Upper**
Online fall 2020 and blended fall 2020									
Pre-Test	1.24	0.271	2.13	29.52	0.042	0.12	0.06	0.00	0.24
Post-Test	2.40	0.129	3.58	33.48	0.001	0.18	0.05	0.08	0.29
In-person fall 2018 and blended fall 2020									
Pre-Test	2.48	0.126	1.27	29.57	0.214	0.08	0.06	-0.05	0.20
Post-Test	2.39	0.132	3.82	30.99	0.001	0.22	0.06	0.10	0.34
Online fall 2018 and fall 2020									
Pre-Test	0.25	0.623	-2.57	37.56	0.014	-0.16	0.06	-0.28	-0.03
Post-Test	0.00	0.953	-1.48	37.72	0.148	-0.09	0.06	-0.20	0.03

*Note. Equal variances not assumed. Fall 2018 is an in-person section and 2020 a blended section. Live fall 2018 (*n*=21); Blended fall 2020 (*n*=12); Online fall 2018 (*n*=18); Online fall 2020 (*n*=31)

Figure 1. Fall 2018 and 2020 ASK scores for live/blended and online students.