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Increasing Student Engagement through Course Attributes, Community, and Classroom Technology: Lessons from the Pandemic

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While many STEM (science, technology, engineering, and mathematics) instructors returned to in-person instruction in fall 2021, others found themselves continuing to teach via online, hybrid, or hybrid flexible (i.e., hyflex) formats. Regardless of one's instructional modality, the findings from our own and other studies provided insight into effective strategies for increasing student engagement and decreasing cognitive overload. As part of this perspective, we included data from undergraduate students, many of whom are first generation and low income and from marginalized backgrounds, to identify instructional practices that helped them thrive and succeed during the recent COVID-19 pandemic. More specifically, we explored the various pedagogies and technologies utilized during emergency remote teaching to identify best practices as we considered the future of teaching. In sharing best practices at our institution, we aimed to provide a framework for deep reflection among the readers and the identification of practices to start, stop, and/or continue at their own institutions.

KEYWORDS qualitative, STEM, undergraduate, instructor, cognitive load, engagement, minority-serving institution

PERSPECTIVE

In spring 2020, the COVID-19 pandemic forced instructors to rapidly transition from in-person teaching to emergency remote teaching (ERT) (1). For those with previous online teaching experience and use of a learning management system (LMS), the transition was likely made with little effort and stress. In contrast to seasoned online faculty, most instructors moved to ERT midcourse based on in-person instructional planning (2). Additionally, since most college instructors have little, if any, preparation in course and/or instructional development, moving courses rapidly online posed many challenges (3). Like their instructors, many students were equally caught off guard and experienced heightened anxiety, financial setbacks, forced relocation, and difficulty maintaining a routine and staying connected to others (4). For undergraduate students identified as low income and first generation and persons excluded due to their ethnicity or race (PEERS) (5), the challenges were cumulative, including lack of a quiet workspace, absence of reliable, high-quality Internet, housing and food insecurity, and increased responsibilities at home (e.g., care of family members). Despite these challenges, instructors and students were resilient and collaborated to find innovative strategies to cope and thrive during ERT (6).

Regardless of the delivery mode, effective teaching and learning result from intentional course design evidenced by solid alignment across course learning objectives, assessments, and planned learning experiences (7). In addition to the effective implementation of evidence-based strategies, research supports a student-centered approach with consistent module structures in the LMS (7). With the spread of the Internet and the World Wide Web in the mid-1990s, online instruction increased rapidly and taught us a great deal about effective online instructional practices (8–12). So, as we begin to imagine what teaching might look like postpandemic, we want to process lessons learned from ERT. This perspective aims to answer the following questions:

1. What did students describe as the most effective and supportive practices employed by instructors during ERT?
2. Looking to the future of teaching, what instructional approaches and strategies should we start, stop, and continue in order to support student engagement?

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BACKGROUND

S. R. Cavanagh (13) argued that engagement is the first step for learning, and this is particularly true in the fields of science, technology, engineering, and mathematics (STEM). According to the National Survey of Student Engagement (NSSE), engagement is a function of both a student's personal desire to engage and institution-initiated opportunities to engage (2–4). Engagement falls into three dimensions: (i) behavioral, (ii) affective, and (iii) cognitive. Behavioral engagement refers to the observable acts of students during learning (e.g., exhibiting effort and persistence, seeking help to solve a task, and in-class participation). Affective engagement is one's emotional states linked to task investment. Cognitive engagement refers to the student's efforts aimed at mastering the core concepts and competencies in a course, and it conveys deep processing of information, critical understanding, and the ability to apply new knowledge to solve challenging problems (14).

In addition to understanding the impacts of engagement on learning, advances in neuroscience have allowed us to better understand the negative impacts stress and trauma have on learning (6, 15, 16). Trauma connotes any experience in which a person's internal resources are not adequate to cope with external stressors (15) and is known to impact emotions, such that an individual's executive functioning and self-regulation skills are compromised. That means faculty and students may have a harder time planning, remembering, and focusing on what they need to teach or learn (16). Additionally, emotions, such as anger, fear, sadness, loneliness, and helplessness, can have a devastating effect on one's levels of energy, interest, and engagement (6). Coupled together, the pandemic and sociopolitical events over the past 18 months increased levels of stress and anxiety for many of our instructors and students. Effective teaching is challenging in the best of times, but in times of crisis and uncertainty we must be able to recognize and mitigate the effect of stress, anxiety, and trauma and apply best practices as we design resilient courses and caring communities (17). As the pandemic continues to lead to change and uncertainty in higher education, we must reflect on the lessons learned during ERT and identify pedagogical approaches that keep trauma in mind, while increasing all dimensions of student engagement.

Lessons learned during ERT

As part of a research study, we conducted instructor and student surveys and interviews to identify supports and barriers during the transition to ERT (18). We found that course attributes, community, and classroom technology were the most frequent support categories that emerged from the student data and that these ideas mentioned were related to reducing cognitive load and increasing student engagement. We defined course attributes as "instructional approaches used and specific components of the course, particularly in the LMS." Community was defined as "a place or group of people that provides you with a sense of belonging, personal value, and support." Classroom technology was defined as "having access to, and the effective use of, hardware, software, and instructional resources." In the sections below, we review our own and previous research findings regarding lessons learned during ERT on course attributes, community, and classroom technology.

Course attributes

The organization and presentation of course material on the LMS can promote student engagement and reduce the cognitive load increased by pandemic-related trauma. According to D. Xu et al. (19), well-organized online courses ensure that the content and materials are consistently broken into distinct learning units of manageable size and presented in a logical progression, such as weekly modules. B. Lake (20) suggested that using a similar sequence and visual appearance in weekly modules on your LMS helps students develop expectations and a routine that will set them up for academic success. Additionally, providing students with an introductory module in the LMS helps students achieve a clear understanding of how to get started, when to find various course components, and how to access different resources online (19), which will ultimately reduce their cognitive load (21). Providing frequent opportunities for participation and interaction among students through online discussion boards allows students to respond to questions, participate equally, and potentially coconstruct knowledge through meaningful discourse (22, 23). Z. Szabo (24) found that the use of peer facilitation in online discussion boards positively impacts student participation and that instructor-facilitated discussions increase the depth and quality of reflections. Finally, assessment plays an important role in the learning process. Formative assessments, like homework or quizzes used during the learning process, help both the instructor and students facilitate and monitor students' progress toward learning objectives or outcomes. Summative assessments, like projects or exams used at the end of a unit or semester, help evaluate individual mastery of course learning outcomes. The use of frequent low-stakes, formative assessments helps students effectively space their study and practice and more consistently engage with the course content and allows instructors and students to monitor progress and adjust their study strategies when needed (25–27).

Community

V. Tinto (28) theorized that students will increase their levels of satisfaction and the likelihood of persistence in a college program if they feel a sense of belonging and develop relationships with other members of the learning community. The sense of belonging in an academic context can influence individuals' motivation, achievement, and well-being (29). Traditionally, students assemble and interact before, during, and at the conclusion of a class session, leading to organic opportunities for social interactions. In the online classroom, students are represented as avatars, text on a screen, and sound bites, potentially

leading to students becoming disembodied entities and a weakened sense of community (30). One student wrote that she "felt cut off and sort of isolated from the class," while another noted the "impersonalness of lectures" and the "difficulty of following lectures when the pace is not as connected with the students' ability to keep up" (18).

While several instructors we interviewed noted the importance of community during ERT, two challenges stand out. First, many noted how difficult communication was with their students. Instructors routinely described being uncertain as to whether students were receiving the information they were sending, and many expressed concerns that the students were being deluged with information, in part because the instructors and teaching assistants were often sending multiple announcements each week. Second, nearly all instructors interviewed noted that "students just become overwhelmed" and many instructors had "concerns for the mental health of [the] students" (18).

Classroom technology

Long before the current pandemic, the growing field of academic technology enabled innovative pedagogy and information sharing using emerging technologies. However, when instructors and students were forced into ERT, it became critical to know about, and have access to, hardware, software, and instructional resources to enhance communication, engagement, and the overall student experience. Universities quickly addressed the most critical needs of instructors and students by providing laptops, tablets, hot spots, headsets with microphones, and access to software available in on-campus labs. Pedagogical coaches and instructional designers responded rapidly to provide instructors with a variety of workshops and consultations regarding the effective use of the classroom technologies. Supportive resources focused on course design, effective assessment practices, engagement strategies, classroom response systems (e.g., polling via Zoom), presentation software, capabilities of the LMS, and collaboration tools (17).

During ERT, some instructors felt students were more productive and engaged when camera usage was required, while other instructors felt chat and breakout rooms facilitated group work and community (25). A. Y. Wang and M. H. Newlin (31) advocated the use of synchronous chat rooms as a means of fostering communication and instructor-student and student-student interactions in the online learning environment. Along with synchronous chat rooms, collaborative work in breakout rooms can help students develop a greater sense of community. However, given that many of our students' out-of-class commitments increased during the pandemic (e.g., employment and care of siblings and/or family members), asynchronous communication via email and discussion boards was equally important.

Many instructors in our recent study (18) mentioned how they appreciated the ease of organizing for group work, whereas others discussed the lack of student (behavioral) engagement once students entered the breakout rooms. We suspect that differences in implementation and group expectations may have contributed to the mixed feelings expressed by faculty. Also, students did not mention anything about breakout rooms specifically, but they did mention that they appreciated synchronous classes, indicating that they liked the personal and live interactions with their peers and the instructor(s). Students also mentioned they appreciated having introductory videos and recorded lectures in each module because these provided them with flexibility in their learning (i.e., cognitive engagement).

ADDRESSING THE PROBLEM/CHALLENGE

As part of our recent study (18), we analyzed student data regarding effective and supportive practices used by instructors during ERT that promote student engagement and reduce the cognitive load increased by pandemic-related trauma. This led to the following recommendations regarding instructional approaches and/or strategies that instructors should start, stop, and continue as we look to the future of teaching. Our recommendations are organized around the three emerging themes: course attributes, community, and classroom technology (Table 1).

Course attributes

Organize course content on the LMS such that students become familiar with expectations and can easily navigate the course materials. We suggest that instructors start to divide content into weekly modules, including an introductory module (or module 0). An introductory module creates a framework for introducing yourself to your students and explaining why you are so interested in the discipline and course (32). One of the main benefits of including an introductory video is to establish instructor presence (33). The introductory module also contains the content of the course syllabus. Following the introductory module, each unit of study should have its own module and follow the same format. A predictable format is created with students in mind. Many instructors develop introductory videos for each unit or content module. These videos, along with other course materials (e.g., readings, quizzes, assignments, etc.), help increase in-class engagement and mastery of the core concepts and competencies. Additionally, we suggest that instructors stop posting unstructured online discussion boards on the LMS. As discussion boards are commonly used in hybrid learning, like flipped classrooms to introduce students to course topics, the key is to make them meaningful, relevant, and instructive so students view them as critical to the learning process and not busywork. Similarly, when assignments are closely aligned with course learning outcomes and assessments, student motivation and engagement increase (34) and cognitive load decreases (35). So, if you already implemented multiple low-stakes, formative assessment, then we recommend you continue them in the future.

TABLE 1
Instructional approaches and/or strategies to start, stop, and continue as we look to the future of teaching organized around the topics of course attributes, community, and classroom technology

Category from the work of C. Donham et al. (18)	Start: what do you wish you would have done? What do you plan to implement in the future?	Stop: which approaches were not effective and/or do not make sense in the future?	Continue: what will you keep using moving forward?
Course attributes	Weekly modules on LMS with module 0 (introductory)	Unstructured online discussion boards on LMS	Multiple low-stakes, formative assessments
Community	Create space for organic social interactions before, during, and after class	Multiple announcements per week from instructional team	Be available, understanding, supportive, and flexible with students (humanizing)
Classroom technology	Prerecord lectures via Zoom, Kaltura, Camtasia, etc.	Inequitable classroom technology resource policies	Zoom for chat, polling, recording, and office hours

Community

To address the loss of community and sense of belonging many students and instructors experienced during ERT, we recommend that instructors start creating space for organic social interactions between students and instructors before, during, and after class. Also, we recommend that instructors stop the deluge of information sent to students and instead compile time-insensitive communications into a weekly announcement sent on the same day each week. This helps ensure that students feel a sense of connectedness to a community and have clarity regarding expectations. Finally, regular "check-ins" at the beginning of class and/or providing a few minutes of silence throughout lectures can help keep students calm and focused on learning (36). To support students' emotional needs, it is critical for instructors to be more available (e.g., Zoom office hours), supportive, and flexible. We strongly suggest that the work of humanizing and building the learning community continue as we move back to in-person teaching. For example, instructors should be understanding of students' unique situations and remove deficit language from course material, such as harsh grading and attendance policies in the syllabus.

Classroom technology

When it comes to best online practices, we have learned a great deal from our students about the promises and potential pitfalls of academic technologies. Students indicated that they liked the personal and live interactions with their peers and the instructor(s) via Zoom but also appreciated having introductory videos and recorded lectures in each LMS module because these provided them with flexibility in their learning (18). As a result, we recommend that instructors start and/or expand the use of prerecorded lectures, as these provide additional opportunities for students to pause and rewatch the recording. This can help students to take and/or check the adequacy of their course notes, process the content more deeply (e.g., elaboration and reflection), and reference the lecture if something is unclear or confusing. Prerecorded lecture videos can reduce cognitive load by allowing students to watch the videos several times and pause and rewind as needed (37). A primary obstacle to overcome at our institution was access to the necessary hardware, software, and instructional resources to succeed during ERT. For students who normally depended on using on-campus computer labs, having access to a computer and audio-video capabilities became essential. Additionally, students from small, rural communities had the added obstacle of nonexistent or unreliable Internet services. In response, the Division of Undergraduate Education at our institution made laptops, headsets with microphones, and hot spots available for checkout. Yet even with this, we know many students still struggled because either they did not know about these loaner programs or they lacked a quiet spot at home to attend class and study. Moving forward, it will be important to stop classroom technology resource policies that are not equitable (e.g., "students are required to purchase a computer") and continue loaner programs and/or the options to purchase technology packages at reduced cost upon admission to the university.

CONCLUSION

Indirectly, the move to ERT helped address the lack of pedagogical preparation evident among many instructors. Faculty, particularly in STEM, were forced to think more deeply about teaching and how to best support student engagement and learning. Indeed, many instructors adopted student-centered pedagogies and explored innovative technologies and instructional resources. Many students articulated that course attributes in the LMS and technologies used by their instructors helped provide clarity and structure, effective and flexible content delivery, clear communication, and a sense of belonging in a community. Yet for others, especially new and first-generation college students, going online was overwhelming. They felt as though a firehose of information was turned on, and this only increased their cognitive and psychological load. Still, we feel as though we have learned a great deal about best

practices for supporting students' academic success. This perspective identifies approaches identified during ERT that instructors should either start, stop, or continue as instructors return to in-person instruction or find themselves continuing to teach online, in a hybrid format, or via hybrid flexible course formats. While these suggestions reflect our current research and understanding, they are necessarily limited to our institution's study population. As a result, while the recommendations are likely reasonable for all STEM faculty, it will be important for instructors to reflect on their own pandemic teaching experiences and tailor their pedagogical choices to their own student population.

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