

Resilient Instructional Strategies: Helping Students Cope and Thrive in Crisis

Jackie E. Shay^a and Cathy Pohan^a

^a*The Center for Engaged Teaching and Learning, Division of Undergraduate Education, University of California, Merced, Merced, California, USA 95343*

Recent times of excessive stress call for a reflection and reformation of how people interact and support one another. This is particularly true in science, technology, engineering, and mathematics (STEM) discipline-based education, where it is becoming increasingly important for course instructors to adopt student-centered teaching approaches that engage students, maintain rigor, and consider the students' learning experiences, including stress. What are some pedagogical strategies that instructors can draw upon to help students cope with trauma and regain a healthy state of learning in an already-challenging field? To prepare instructors for the transition to remote instruction, a variety of evidence-based pedagogical and technological approaches were designed to promote resilient student-centered classrooms and facilitate student development and care in times of crisis. This perspective provides an overview of the salient research behind these strategies, highlights those that instructors found most useful, and concludes with planned next steps in the continued effort to support instructors.

INTRODUCTION

For students in STEM academic programs, the challenges associated with learning the hallmark skills of a successful scientist, such as navigating scientific obstacles, persevering through the pressure to perform and publish, and coping with failure (1) are exacerbated by the unique excessive stressors from recent crises (2). The unnatural act of social distancing and increased remote interactions initiated by COVID-19 has dramatically changed living conditions, causing economic-, health-, and education-related hardships. A recent survey of 2,086 college students found that remote learning has disrupted students' lifestyles, with most students experiencing anxiety (91%), disappointment or sadness (81%), and loneliness or isolation (80%) (3). Of those surveyed, nearly half (48%) have experienced financial setbacks and forced relocation (56%), and over half of students also reported difficulty (i) maintaining a routine, (ii) getting enough physical activity, and (iii) staying connected with others (76%, 73%, and 63%, respectively) (4). The growing socio-political divisiveness in the United States and ravaging forest fires in the West have intensified the level of trauma and pose additional disruptions to remote teaching and learning (5). For persons excluded due to ethnicity or race (PEERs), the culmination of these challenges has added

to the long-term struggle associated with the systemic consequences of exclusion and underrepresentation in STEM (6). Many low-income, first-generation students also struggle with a lack of quiet workspaces, the absence of Internet and other technological tools, housing and/or food insecurity, and the added responsibilities associated with being at home and helping the family (e.g., employment, care, etc.). Stress, anxiety, and traumatic events contribute to students' cognitive load, making the focus on learning more challenging. Cognitive load theory refers to the number of resources in working memory that are used for processing, encoding, and recalling new information (7, 8). Under high-intensity conditions, the human brain manages by developing a system to tolerate or minimize excessive stress and overrides cognitive sources of energy deemed less of a priority, such as learning (9). Specifically, traumatic incidents interrupt executive functioning and self-regulation (10), making it harder for students to plan, remember, and focus (11), which often results in lower performance and reduced student engagement (12–14). Given the impact of stress on learning in STEM, how can instructors help students cope and thrive in these unprecedented conditions?

PEDAGOGIES THAT HELP STUDENTS COPE

Teaching requires developing a safe and flexible learning environment, and in times of crisis this environment must be resilient. Resilience refers to the capacity to adapt to changing circumstances and can be obtained by implementing evidence-based teaching practices that encourage

Address correspondence to Jackie E. Shay, jshay@ucmerced.edu.
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flexible approaches to learning (15). Using student-centered pedagogies, instructors can intentionally design resilient online learning environments without compromising rigor (16, 17). Such techniques include reducing cognitive load by amplifying core concepts and competencies, rethinking assessment, and using trauma-informed teaching.

Cognitive load, core concepts, and competencies

A number of evidenced-based strategies can be implemented to reduce cognitive load and support student learning. First, instructors must focus on amplifying core concepts and competencies outlined in the course learning outcomes. In *Vision and Change* (2011), the American Association for the Advancement of Science emphasizes the importance of shifting focus from content “coverage” to clear and aligned learning outcomes (18), which results in improved student learning (19, 20). This is particularly important in STEM, where “the drive to ‘cover content’ presents a formidable barrier to incorporating more student-centered practices” (21). Core concepts are discipline-based ideas and/or principles for which students must have a deep and lasting understanding, and competencies are the skills students must possess to be successful within the discipline beyond the classroom. *Vision and Change* proposed core concepts for STEM education, and several disciplines have followed suit (22), including the American Society for Microbiology (23). Second, instructors should consider making content relevant to students’ lives. Deep and lasting learning requires that students engage with, reflect upon, and apply content to real world problems (24–28). Additionally, using model examples helps students develop a conceptual understanding of the material and place those understandings within the larger context of the discipline (21). For example, in microbiology, symbiotic interactions, nutrient cycling, and fermentation can all be discussed using the relationship between a cow and its rumen microbiome. By utilizing this particular model, students better understand the interrelatedness of these concepts and how to apply them in other biological scenarios. Lastly, chunking content into smaller, more manageable pieces can assist the brain with organizing and encoding new information into long-term memory (25, 29, 30). Learning guides, explicit expectations, and a user-friendly organization of content in the online learning management system (LMS) also provides students with a pathway to conceptual understanding (31).

Rethinking assessment

The purpose of assessment in the student-centered classroom is to gather relevant information about student performance related to course learning outcomes. Formative assessments help monitor student progress and adjust instruction accordingly. These assessments (e.g., reflections, quick writes, discussion boards, quizzes, participation, homework)

often contribute a smaller percentage toward the final grade, while summative assessments (e.g., mid-terms, finals, projects, papers, performances) are used to evaluate mastery of learning outcomes and are often weighted more heavily in the course (32, 33). Instructors should reevaluate the frequency, weight, and distribution of assessments in a resilient online course. It is critical in times of crisis to consider using frequent, low-stakes assessments that will give students ample opportunity to practice, receive feedback, and monitor their progress, thereby reducing the stress and anxiety associated with performing well on a few high-stakes assessments (34, 35).

Trauma-informed pedagogy and creating a sense of community

Student motivation, or the willingness to engage actively with course content and instruction, is influenced by a student’s sense of belonging, value, and well-being in the classroom (11, 36–38). Trauma-informed pedagogy aims to recognize student experiences inside and outside the classroom and create an emotionally and psychologically safe environment where students feel comfortable sharing their ideas, opinions, and perspectives free of ridicule or harassment (11, 39, 40). Communication and collaboration are also central to building a safe learning community (41). Methods to facilitate this form of teaching online include giving students multiple opportunities to share their experiences with each other and collaborate on learning tasks. Instructors must (i) provide expectations for in-class and online communications and (ii) prepare to manage emotional responses that students may display when discussing emotionally charged topics (e.g., genetics, evolution, etc.). Instructors who intentionally create space for students to safely share their challenges and successes and offer their own personal experiences in turn will help students connect as people first and as learners second (11). This can be done asynchronously in a discussion board or synchronously by spending a few minutes before or after class having a casual conversation (11, 38). Most importantly, being authentic and establishing a strong presence will help develop trust and community in online environments. Trauma-informed practices are inherently flexible and help students to regulate their own learning through mindfulness and alternative pathways to learning (42).

STRATEGIES AND TOOLS FOR RESILIENT CLASSROOMS

The professional development materials outlined here focus on reducing cognitive load, amplifying core concepts and competencies (25, 43), implementing trauma-informed pedagogy (11, 38, 41) and engagement strategies (28), and rethinking assessment practices (44, 45). It is recommended that instructors utilize the following strategies to establish

conditions within the learning environment to help students deal with additional stress and regain their sense of equilibrium.

Identify and amplify critical content

In order to identify core concepts critical to meeting course outcomes, instructors should first ask: What are the essential bodies of knowledge, skills, and dispositions associated with this course? What extraneous material may be causing unneeded complexity and/or distraction for students? Second, instructors should ask: How can the course be organized such that students can more easily navigate the content and materials in the LMS? Instructors are encouraged to discuss core concepts with students and demonstrate how they can achieve these competencies through a roadmap based on the learning outcomes. For example, a core concept of microbiology may be the relationship between the structure and function of a cell and a learning outcome of the course may be to explain how to use a microscope to determine cell wall features and their function (23). Core concepts may connect to multiple units of the course. Instructors should remind students when this happens so they can understand the relationship of core concepts within course materials. One technique for creating a logical, user-friendly visual organization is chunking content into modules by units of study or weeks in the semester. With regard to content delivery, instructors should avoid long, synchronous lectures, and instead use time spent with students to (i) emphasize major concepts or principles, (ii) address common misconceptions in the discipline, and (iii) clarify expectations for upcoming assignments. Instead of lengthy or dense readings, consider selecting multimedia sources such as online videos, tutorials, or concise articles that will help convey content. Consider creating minilectures or “recap” videos to ease cognitive load and support student learning.

Increase online communication and collaboration

Clear, open, and frequent communication is the linchpin to any successful relationship, including those in the classroom. Students desire connection in an online learning environment and perceive the instructor as the facilitator of classroom climate and student-student rapport (46). To mitigate feelings of loneliness and isolation, instructors can build classroom climate by increasing communication between students and themselves. Student-instructor interactions can be facilitated through regular announcements, which give students focus and clarify assignment expectations. Feedback through rubrics, messages, videos, or audio technologies in the LMS keeps students on track and communicates care and concern to students. Student-student interactions can be facilitated through group activities such as discussion boards, Zoom breakout rooms, shared documents, or synchronous discussions. Beyond the socio-

emotional benefits, working in groups can also reduce cognitive load since processing content and completing complex tasks can be shared among several individuals. While individuals still need to integrate information and coordinate their learning, group work often results in deeper processing, elaboration, and more meaningful learning than individual work (47).

Engagement strategies

Deep learning is reflected in one's ability to apply core concepts, principles, and competences in novel situations, and is made possible by generative activities that prompt reflection and elaboration. To help students engage deeply with the content during synchronous sessions, instructors can integrate purposeful pauses such as quick writes, minute papers, or polling (48, 49). Cognitive aids, whether instructor-provided or collaboratively produced, can facilitate deeper understanding by making explicit important concepts, principles, and connections among ideas (50). Some examples of cognitive aids include timelines, flow charts, concept maps, visual images, etc. Each of these examples can be used to cover multiple concepts in a course. For example, consider the various stages of pathogen infection along with its associated virulence factors. By using a concept map, student can describe how each stage connects to a virulence factor, by using a timeline, students can explain the order of events, or by using a diagraph, students can distinguish where each stage of infection occurs. Regarding engagement of the whole class, learning guides in the LMS can pave the way for achieving course learning outcomes. By breaking down complex tasks or ideas into their component skills or essential understandings, students can practice subskills individually and then in combination to master the material (27). Finally, in content-heavy STEM courses, active learning strategies improve student engagement and provide opportunities for focused practice and discussion of core concepts, benefitting female and PEER learning in particular (28).

Prioritize learning and rethink assessment

In times of crisis, a student-centered class where students have a choice and authority over their learning creates a sense of power and responsibility in a time when many things seem beyond their control. When instructors focus on the process of learning they communicate the student onus of developing an understanding and mastery over memorization and recall. To give students some choice in their process, instructors can provide a few topic options for students to investigate and then let them choose how they prefer to demonstrate their newfound understanding (e.g., a podcast, a poster-type presentation, a written paper). Similarly, reflections and short essay-style prompts offer a method for expressing individual thoughts and ideas about the material. Assessing learning can be as varied as

TABLE I
Workshops and strategies to promote resilient remote instruction.^a

Resilient strategies and Salient Literature	Faculty workshops and Courses	Learning outcomes
1 Amplify critical content and reduce cognitive load (8, 11, 21, 22, 27, 43, 47)	1. Faculty and TA Institutes: Plan, Build, and Engage 2. Zoom for Instruction and Zoom Security 3. Using Canvas to Organize/Chunk Course Content into Modules 4. Creating Instructional Videos	1. Identify strategies to reduce cognitive load. 2. Identify core concepts, principles and competencies for your course design. 3. Utilize the appropriate technologies to engage and support student learning in the online environment.
2 Build community and collaboration (4, 17, 24, 26, 28, 38, 44, 45)	1. Faculty and TA Institutes: Plan, Build, and Engage 2. Implementing Engagement Strategies and Mitigating Resistance/Non-participation 3. Using Microsoft Teams for Instruction 4. Zoom for Instruction and Zoom Security	1. Create a “to do list” for developing a welcoming and inclusive learning community that reflects “best online practices.” 2. Identify 3 to 5 evidence-based engagement strategies to use in the fall. 3. Identify 2 evidence-based strategies to mitigate student resistance to active learning. 4. Utilize the appropriate technologies to engage and support student learning in the online environment.
3 Employ engagement strategies (24, 26–28, 43, 44)	1. Faculty and TA Institutes: Plan, Build, and Engage 2. Overview of Canvas Features, covering basic navigation and how to create assignments, announcements, discussion boards, and quizzes	1. Identify 3 to 5 evidence-based engagement strategies to employ in the fall. 2. Identify evidence-based strategies to mitigate student resistance to active learning. 3. Utilize the appropriate technologies to engage and support student learning in the course shell.
4 Rethink assessment	1. Rethinking Assessment: Integrity, Best Practices and Creating Rubrics 2. Using Canvas Gradebook and Analytics to Keep Students on Track	1. Evaluate the appropriateness of previously planned assessments with regard to high- vs low-stakes. 2. Determine potential modifications to reflect a variety of purposes and types of assessment, with more frequent low-stakes assessments. 3. Utilize features of Canvas Gradebook to monitor student engagement and support their learning.

^aThe four strategies for resilient remote instruction are outlined with associated supportive literature. These strategies are directly tied to the offered workshops and courses that cover each strategy discussed. Some workshops covered more than one strategy. General learning outcomes for the represented categories are outlined and cover the overall goals for instructors participating in the workshops offered.

the process of learning itself. The primary purpose for assessment should be to gauge student learning and collect data that can inform subsequent instruction. A thoughtfully designed rubric is a powerful assessment tool in the trauma-informed classroom. Rubrics offer clear, comprehensive, and agreed upon scoring that ensures equity and confidence in the grading and feedback process, thereby improving student-instructor communication of how and when learning is achieved. Whether using an analytical rubric to assess creativity from a writing assignment (51) or specifications grading, a flexible grading system designed to assess performance without a letter grade, point value, or attendance (52), to assess competency of laboratory skills, rubrics are key in rethinking the purpose of, and approaches to, assessment. Lastly, when designing a student-centered course focused on learning, the use of frequent low-stakes

assessments (i.e., polls, quizzes, quick writes, discussion boards, etc.) is correlated with high student self-efficacy and motivation (53).

Using these strategies as a framework, pedagogical coaches from the Center for Engaged Teaching and Learning (CETL) at the University of California, Merced, partnered with instructional designers from Academic and Emerging Technologies (AET) to help instructors plan ahead for unforeseen and uncontrollable disruptions to teaching and learning by intentionally designing resilient courses for the remote environment (Table I). Content was targeted to all instructors across the campus with particular emphasis toward instructors new to online instruction. Instructors from all levels (teaching assistants, lecturers, assistant and associated professors) and from all schools (engineering, social sciences and humanities, and natural sciences)

TABLE 2
Workshop descriptions and time commitments.^a

Instructional workshops	Description
Faculty and TA Institutes: Plan, Build, Engage (3 hours)	This three-part series covers the basics of pedagogy and technology and “best practices” for developing resilient online courses. In part one (plan), instructors learn about cognitive load and how to center a course on the “core concepts.” In part two (build), instructors learn many technology tools available to implement a course online. In part three (engage), instructors learn how to build a community and engage students online, along with pedagogical methods to mitigate resistance to engagement in an online setting.
Implementing Engagement Strategies and Mitigating Resistance (1 hour)	This workshop dives deeper into the ways to engage students online by focusing on simple strategies such as being personable, offering relatable examples, creating clear expectations and guidelines, and providing varied ways for students to interact with the instructor, the content, and each other. Examples for both synchronous and asynchronous courses, as well as small and large classes, were also discussed.
Rethinking Assessment (1 hour)	This workshop focuses on the purpose of different assessment types. Instructors discuss the benefits of frequent, low-stakes assessments in an online learning environment. Examples of both high-stakes, low-stakes, synchronous and asynchronous assessments are discussed in detail with technological tools that can facilitate each type of assessment.
Canvas LMS Sessions	
Creating Instructional Videos (1 hour)	This workshop covers how to record, edit, and upload instructional videos using Zoom, Camtasia, and the Canvas learning management system.
Overview of Canvas (1 hour)	This workshop covers a deeper exploration of all the tools and technologies in Canvas. Specifically, instructors learn basic system navigation, how to create assignments, announcements, and quizzes, and how to set up the learning environment effectively.
Using Canvas to Organize/Chunk Course Content into Modules (1 hour)	This workshop covers benefits, tips, and templates for chunking course content into modules that can be easily to navigate and access by students. Instructors are encouraged to be interactive during this workshop by opening their course sites and begin chunking content into more manageable pieces. It also covered the set-up of assignments, quizzes, discussion boards, files, pages and home page with reference to overall course organization.
Using Canvas Gradebook and Analytics (30 minutes)	This workshop covers the nuances of grading and understanding grades in Canvas. Specifically, instructors are given tools on how to keep students on track and monitor performance effectively. Examples are provided for how to build quizzes and questions that will produce quality course data.
Zoom and Teams	
Zoom for Instruction (1 hour)	This workshop guides instructors through all the features, settings, and tools integrated in Zoom. Specifically, they are given the best tips for teaching classes such as enabling breakout rooms, reactions and raising hand features, Zoom whiteboard for annotations, sharing screen and audio, and polling.
Zoom for Security (1 hour)	This workshop introduces ways in which Zoom security can be compromised and discusses ways to safeguard the classroom and student’s privacy. This includes how to set up the Zoom room to manage participants, create passwords, establish a waiting room culture, and controlling the chat.
Using Microsoft Teams for Instruction (1 hour)	In this workshop, instructors are guided through Microsoft Teams, and learn about the benefits of using teams, conditions where this technology will be more useful, how to set up the Teams, how to navigate and facilitate the Teams environment, and how to communicate with Team groups and Team networks.

^aDetailed descriptions of all workshops and courses offered by UC Merced’s CETL and AET teams as they prepared instructors to transition from emergency remote instruction to resilient remote instruction.

participated. Provided examples were varied to accommodate instructors teaching labs, small discussions, or large lectures. Instructors were provided several opportunities to learn and practice teaching online. The crash course “Faculty Institute” and “TA Institute” covered the basics of

planning, building, and teaching an online course with 111 faculty participants and 87 graduate teaching assistants (GTAs). The more targeted workshops focused on pedagogy and technology and had a total of 76 faculty participants and 12 GTAs. One-on-one consultations provided

individualized support and troubleshooting to 49 faculty and 46 GTAs. Of those reported, a total of 236 faculty and 145 GTAs were supported through these programs. Detailed descriptions of the workshops offered are outlined in Table 2. The team also contributed to a campus-wide, biweekly resource newsletter for faculty and created both a faculty and graduate student course in the campus LMS, containing a plethora of additional resources, videos, tutorials, and discussion board support.

CONCLUSIONS AND RECOMMENDATIONS

As instruction progresses, the strengths and areas for improvement regarding the focused workshops and the Faculty Institute are becoming clear. Instructors came away from the workshops with a better understanding of the importance of reducing cognitive load, building community, and engaging students. They shared that chunking content into modules and organizing the course using a visual guide has proven to be highly effective for communicating with students, clarifying course expectations, and reducing cognitive load. For many classes, particularly smaller, discussion-based courses, the Zoom breakout rooms and interface are working well to establish community and give students opportunities to work together and build community. Instructors noted that recording lectures through video, creating introductory welcome videos, or offering alternative resources outside of a traditional lecture, has been effective in delivering content while freeing up time to dive into material during synchronous “lecture” hours. Lastly, instructors believe strategies for engaging students online, such as polling, relatable examples, and being personable has motivated students to participate more than was experienced during the emergency remote instruction of spring 2020. Frequent polling has proven to be a successful engagement strategy in large classes (> 200) and serves as a manageable, low-stakes assessment. One faculty reported feeling pleased to see the impact of “reaching students in different ways” and will consider using many of these strategies even after returning to face-to-face instruction.

While many instructors have shared positive feedback, others are experiencing a number of challenges as they adjust to teaching in a remote setting. The vast majority found the learning curve of novel teaching practices (e.g., communicating frequently, offering frequent low-stakes assessment, creating relatable examples) and technology (e.g., organizing breakout rooms, creating online course content, recording lectures, setting up the course in the LMS) to be time-consuming. For large classes (>100 students), Zoom breakout rooms are not an effective strategy and often result in management challenges (e.g., organizing and assigning breakout rooms) that distract from instructional time. Courses that require hands-on instruction, such as labs, are finding it particularly difficult to teach techniques and skills remotely without laboratory tools and equipment.

The UC Merced pedagogical and technology coaches are learning the importance of reducing the cognitive load and anxiety carried by instructors who are teaching remotely for the first time and expect perfection when implementing several new pedagogies. In the future, it is important to emphasize that transitions are progressive and iterative processes. Instructors are encouraged to start implementing less-complex strategies (e.g., creating a welcome video, organizing content in the LMS, polling) and work up to more complex and time-consuming strategies (e.g., prerecording minilectures for asynchronous learning, polling students, etc.) based on their level of comfort and willingness to commit to novel pedagogical approaches. In general, instructors are feeling overwhelmed, finding it difficult to restructure their courses for the remote environment in such a short amount of time.

The transformation to resilient instruction is without a doubt time-consuming and frustrating, however, the flexibility built into these online courses will provide a better learning experience for students now and in the future. The resilient instructor must recognize that teaching is already a demanding practice of care and that an elevated level of stress and trauma requires elevated care of both students and the instructor themselves. To prevent instructor burnout, instructors are reminded to simply do their best, focus on balancing self-care with the care of their students, and recognize and express that this is an emotional time for everyone (54). Strategies implemented by instructors during this time of crisis will not only bolster the integrity of STEM courses but will continue to do so as stressors from recent traumatic events dissipate. Despite being overwhelmed, students have expressed feeling supported and appreciative of the level of care going into classes. One biology faculty member shared, “students were praising me in the Zoom chat today because they feel like they are learning a lot from my class. That is entirely because I followed [CETL’s] advice.” Another faculty member expressed feelings of relief after participating in several workshops and consultations: “I felt the clouds over me lift immediately.” Throughout these challenging times, a unique transformation is in progress in how instructors are thinking about teaching and learning. Equipped with student-centered, resilient online teaching strategies, instructors can help students not only cope, but thrive during these unprecedented times.

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