

Training Faculty as an Institutional Response to COVID-19 Emergency Remote Teaching Supported by Data

Lisa L. Walsh,^{1*} Sandra Arango-Caro,¹ Emma R. Wester,^{2*} and Kristine Callis-Duehl¹

¹Donald Danforth Plant Science Center, St. Louis, MO 63132; ²Department of Biology, St. Louis University, St. Louis, MO 63103

ABSTRACT

In March 2020, colleges in the United States rapidly switched in-person courses online because of the COVID-19 pandemic. To chronicle how biology faculty responded to this emergency remote teaching, we surveyed faculty across the United States in August of 2020. Our survey included open-ended questions to identify a memorable moment, difficulties encountered, and unexpected benefits during the first COVID-19 semester. Faculty responses were coded by two researchers, and 21 themes emerged. Seventeen coding themes corresponded to one of four facets of adult personal resilience theory, and we used nonparametric statistical tests to compare resilience between inexperienced and experienced online instructors, as well as trained and untrained instructors. Experienced online instructors were more likely to describe an act of kindness in their memory but were also more likely to include negative student behavior as a difficulty. Untrained faculty were the only instructors who included student engagement as a difficulty and were more likely to describe a negative, discouraging memory. We used conditional forest analysis to identify polarizing themes between faculty with and without previous experience teaching online and between faculty who did and did not receive formal training. Our results underline the importance of training faculty, including experienced instructors, to improve emergency preparedness.

INTRODUCTION

Across the globe, higher education institutions moved classes online in response to the coronavirus disease (COVID-19) pandemic, relying primarily on virtual learning management systems (LMS) such as Blackboard, Canvas, and Moodle. In the United States, the first universities, including the University of Washington and Stanford University, announced their transition from in-person to virtual classes on March 6, 2020 (Dorn, 2020). As cases spread, many other U.S. institutions adopted this model before the end of March. Some universities immediately transitioned, some provided instructors (a label that will be used interchangeably with “faculty” in this paper) with a brief delay to allow for course adjustments, and some experienced a more significant delay due to a lack of resources and the necessary infrastructure to provide online remote learning. Regardless of the timing of transition to remote learning, many institutions lacked access to professional development for faculty to convert their in-person course materials to digitally dynamic and engaging online materials while implementing evidence-based online teaching practices (Crawford *et al.*, 2020).

Traditionally, university staff who train faculty to implement an online course have a relatively small, manageable number of faculty clients who begin planning their courses between 6 and 9 months in advance. With the sudden unexpected transition from in-person classes to remote teaching across entire campuses, the support staff was stretched thin, lacking the time and resources to provide the normal level of support (Hodges *et al.*, 2020). Properly developing an online course takes months of

Elisabeth Schussler, *Monitoring Editor*

Submitted Dec 8, 2020; Revised Apr 16, 2021; Accepted Apr 23, 2021

CBE Life Sci Educ September 1, 2021 20:ar34
DOI:10.1187/cbe.20-12-0277

*Address correspondence to: Lisa L. Walsh (lwash@danforthcenter.org).

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planning, and even with course materials and syllabus already created, converting an in-person course to an online format requires time to consider delivery methods, develop alternative student assessments, and learn how to engage in online pedagogy. For faculty inexperienced in teaching online, the rapid transition to online instruction in the midst of a shift in teaching methods would not have provided instructors with enough time to convert to an online course that matched the effectiveness of their in-person instruction (Hodges *et al.*, 2020).

Emergency Remote Teaching versus Online Courses

To distinguish remote teaching that would be in person were it not for a crisis (e.g., the COVID-19 pandemic) from well-designed and thoroughly planned online teaching, Hodges *et al.* (2020) proposed a specific term for the rapid and unexpected shift to online teaching: emergency remote teaching (ERT). The main objective of ERT is to continue student education via LMS for classes that would normally be taught in person or as blended courses (Hodges *et al.*, 2020).

For some institutions, the reliance on LMS as a response to emergency disruptions comes with precedent. When influenza A (H1N1) was declared a pandemic in June 2009, some U.S. universities reviewed their technology infrastructure to evaluate their ability to enable distance learning and augment traditional classroom learning. During the summer of 2009, these universities requested that faculty attend workshops to better understand the chosen LMS and, in some cases, learn how to transition their class to an online format if the H1N1 pandemic led to campus closures (Young, 2009; Ekmekci and Bergstrand, 2010). The ERT continuity programs developed in 2009 were never actually tested in the United States during the H1N1 pandemic, however (Ekmekci and Bergstrand, 2010).

Higher education researchers face difficulties collecting data because of the tumultuous events that coincide with ERT (e.g., McNaught, 2004; Czerniewicz *et al.*, 2019). Instructors are often shocked and overwhelmed at the onset of ERT (Fox, 2004; McNaught, 2004; Czerniewicz *et al.*, 2019). Previous ERT cases in Hong Kong, Lebanon, and the United States underline the importance of faculty being comfortable using technology, including LMS, to teach online (Fox, 2004; SchWeber, 2008; Young, 2009). During the 2003 SARS outbreak in Hong Kong, for instance, instructors with a stronger technology background were less concerned with logistics and more focused on higher learning and online pedagogy (Fox, 2004). A common theme across these disruptive events is the desire to learn from an ERT experience in order to continue improving teaching into the future (Fox, 2004; McNaught, 2004; Czerniewicz *et al.*, 2019).

Faculty Experience and Training

Online teaching experience and formal training in online teaching are factors that affect faculty teaching performance and self-efficacy. Research across a discipline-diverse group of faculty members demonstrated a positive relationship between online teaching self-efficacy and semesters of experience teaching online (Horvitz *et al.*, 2015). This higher self-efficacy for experienced online instructors was most noticeable when it came to managing their classes in an online environment (Horvitz *et al.*, 2015). Morris and Finnegan found that experienced online instructors were better able to engage their students socially, pedagogically, and technologically (2008–2009). It is therefore

not surprising that, at the onset of the COVID-19 ERT, some departments turned to their experienced online instructors to serve as experts for inexperienced faculty (e.g., Holton, 2020).

For faculty lacking experience in teaching online, formal training can serve as a viable alternative to a departmental expert. Across a group of nursing faculty with varying levels of previous online teaching experience, those who took a seminar in online teaching had higher teaching self-efficacy (Richter and Idleman, 2017). Similarly, online instructors who took a 6-week intensive course grew more confident in both their pedagogical and technological abilities (Roman *et al.*, 2010). While training courses in online teaching can improve instructor practices and self-confidence, it may not improve their student evaluation scores, as instructors seeking training may already be effective teachers in their classes (Brinkley-Etzorn, 2018). Due to the need to rapidly adapt to online teaching during a crisis, faculty experience and training in online teaching may be important factors to consider when evaluating the COVID-19 ERT from a faculty perspective.

Framework

Here, we evaluate the pedagogical resiliency of faculty at the onset of ERT in relation to their previous experiences teaching online and any formal training they received for implementing online teaching. In previous disruptions affecting higher education, relevant literature used the ability to maintain and continue education as a measurement of resiliency for the university (e.g., SchWeber, 2008; Young, 2009). In this paper, we present a pedagogical resilience framework (Table 1) based on adult personal resilience theory (Taormina, 2015) and distance-learning best practices (Moore, 1993) to examine ERT resiliency at the faculty level.

Adult personal resilience is composed of four facets of the individual in such circumstances: their determination, their ability to endure, their adaptability, and their ability to recover from adversity. For our pedagogical resilience framework, we interpreted how these facets would manifest specifically in academia (Table 1). Determination is the conscious decision to persevere and would manifest as a demonstrated effort to boost class morale. Endurance is the physical or cognitive strength to withstand adverse situations and would be demonstrated by instructors teaching despite difficulties. Adaptability is having the flexibility to adjust behaviors to better suit changing conditions, specifically instructors changing to better match student needs during crisis. Ability to recover can include cognitive or physical recoveries from a trial and would be demonstrated when instructors have the cognitive ability to reflect and learn from their experiences during the crisis (Taormina, 2015).

To align student success with instructor resilience, we extended the pedagogical resilience framework to examine instructor behavior that is known to improve student outcomes in distance learning (Moore, 1993). Transactional distance theory posits that, in online education, distance should be measured on a transactional level, rather than a spatial one. Transactional distance refers to the psychological and communication space between student and instructor that can lead to miscommunications and misinterpretations. To improve distance education by reducing transactional distance, an instructor should create a course with 1) flexibility rather than a rigid class structure, 2) increased and quality communication with students,

TABLE 1. Pedagogical resilience framework based on the four facets of adult personal resilience (Taormina, 2015): determination, endurance, adaptability, and recovery, as well as best practices to support student learning and well-being based on transactional distance theory (TD; Moore, 1993)^a

	Determination	Endurance	Adaptability	Recovery
Academic manifestation	Classroom environment/ morale buoyed	Teach through difficulties	Instructor teaching to better match needs during crisis	Instructor cognitively able to reflect, suggesting return to “normal”
Coding themes related to the outcome	<ul style="list-style-type: none"> • Memory included kindness • Memory included sense of belonging • Type of memory (positive) • Benefit = got to know students • Benefit = heard from shy voices 	<ul style="list-style-type: none"> • Difficulty = losing face-to face interaction • Difficulty = student Internet access • Difficulty = technology • Difficulty = time management • Difficulty = student engagement • Difficulty = negative student behavior • Difficulty = sense of community • Difficulty = student hardship 	<ul style="list-style-type: none"> • Memory elicited change • Benefit: learned skill • Benefit improved teaching • Benefit = got to know students 	<ul style="list-style-type: none"> • Memory elicited change • Observed benefit • Benefit improved teaching
Target student outcomes	Increased communication	Few online pedagogy difficulties	Increased flexibility, class structure	Overall, transactional distance is small
Coding themes related to the outcome	<ul style="list-style-type: none"> • Memory included TD aspect—communication • Benefit included TD aspect—communication 	<ul style="list-style-type: none"> • Low difficulty with TD 	<ul style="list-style-type: none"> • Memory included TD aspects—flexibility, structure • Benefit included TD aspects—flexibility, structure 	<ul style="list-style-type: none"> • Low rate of difficulty with TD • High rate of TD aspects in memory and benefit

^aRelevant coding themes are included for each facet of resilience.

and 3) reduced reliance on learner autonomy by providing enough guidance and structure that students can succeed in the online space (Moore, 1993). We overlaid these three behaviors onto the four facets of resilience to evaluate the pedagogical engagement that instructors had with their students during the COVID-19 ERT (Table 1).

Research Questions

While the acute and long-term psychiatric effects of the COVID-19 pandemic are not yet known, experts expect a rise in anxiety, stress, and depression (Holmes *et al.*, 2020). In a survey of the general public in China, more than half of participants were psychologically impacted by the coronavirus outbreak, with female participants more likely to be affected (Wang *et al.*, 2020). At times of heightened stress, an individual focuses on survival rather than cognitive growth or self-fulfillment (Levine and Ursin, 1991). We predicted faculty with more exposure to online teaching through experience or training would demonstrate increased resilience and would have a greater ability to engage pedagogically at the onset of ERT.

To understand how ERT impacted faculty and how this impact varied among faculty with different exposures to online teaching, we developed two research questions to evaluate faculty with varying levels of online teaching experience and with varying levels of formal online training.

1. Which putative signals of pedagogical resilience varied between online experience levels? We used nonparametric statistical analyses to evaluate variation between pedagogical resilience signals to determine: Were faculty with online

teaching experience more likely to demonstrate resilience during ERT? Were faculty with online training experience more likely to demonstrate resilience during ERT (Taormina, 2015)?

2. What experiences were most polarizing between online experience levels? We used classification and regression-tree analysis to evaluate: How did faculty survey responses differ between faculty with online teaching experience and those without? How did faculty survey responses differ between faculty with online training and those without?

METHODS

Survey

Faculty were asked through biology and biology education Listservs (ecology instructors via ECOLOG, biology education instructors via SABER, chemical education instructors via ChemEd Listserv, field biology instructors via MAMMAL Listserv and American Society for Plant Biology discussion board, and general biology instructors via the *Chronicle of Higher Education* social media page) to participate in an anonymous survey after the conclusion of the Spring 2020 term, the first to experience COVID-19 ERT (Danforth IRB_2020_05). The faculty survey consisted of four informational questions and five open-ended questions. The informational questions asked faculty what type of institution they teach at, the U.S. region in which they teach, if they had previous experience teaching online, and if they received formal training in online teaching during or after the COVID-19 transition (Table 2). The open-ended questions asked faculty what difficulties they encountered

TABLE 2. Survey questions administered to biology faculty via Qualtrics

Informational questions	
Question	Response options
What type of university/college do you teach at?	<ul style="list-style-type: none"> • Community college • Master's-granting institution • Minority-serving institution • PhD-granting institution • Primarily undergraduate institution • Research-intensive institution
In which region of the USA do you reside/teach?	<ul style="list-style-type: none"> • Mid-Atlantic • Midwest • Northeast • Northwest • Southeast • Southwest • West
Have you taught online prior to COVID-19?	<ul style="list-style-type: none"> • No • Yes
Have you received formal online training since COVID-19 started (either during the transition or after)?	<ul style="list-style-type: none"> • Yes, after the transition to online • Yes, during the transition to online • No
Open-ended questions	
Describe a memorable moment you had when teaching online during COVID-19.	
What made this moment memorable?	
How did this moment impact your teaching?	
What difficulties did you encounter teaching online?	
What unexpected benefit(s) did you encounter teaching online?	

teaching online and what unexpected benefits they encountered teaching online. Faculty were also asked to describe a memorable moment they had when teaching online during COVID-19, what made this moment memorable, and how the moment impacted their teaching (Table 2).

Faculty responses to the open-ended questions were read multiple times to identify emerging themes, then independently coded for 21 coding themes by two researchers (L.L.W. and S.A.-C.) and reviewed for consensus. Faculty responses were also read by the same two researchers for evidence of whether faculty had difficulties with reducing transactional distance or whether they improved transactional distance in their answers to either their unexpected benefit or memorable moment survey responses. After initial coding, interrater reliability, measured using Cohen's kappa, was 0.85 for memorable moment codes (Supplemental Table 1), 0.78 for difficulty codes (Supplemental Table 2), and 0.72 for unexpected benefit codes (Supplemental Table 3). The two researchers (L.L.W. and S.A.-C.) used open discussion to resolve coding disagreements. This included identifying misinterpretations of coding, explaining idioms, identifying mistypes, collapsing codes that were too difficult to distinguish, and resolving disagreements until a consensus was reached.

Pedagogical Resilience Analysis

Two researchers (L.L.W. and S.A.-C.) independently reviewed the 21 coding themes to conduct thematic mapping and reach a consensus that identified themes that fell under the definition

of each facet of pedagogical resilience, as defined in our framework (Braun and Clarke 2006; Table 1). We identified 17 coding themes (Table 1) that fit within an academic manifestation of at least one of the four facets of resilience: determination, endurance, adaptability, and recovery (Taormina, 2015; Table 1). Of the four remaining coding themes, the observed unexpected benefit theme of improved quality of life was excluded from the framework, while the three coding themes related to transactional distance theory were placed in the target student outcomes section of the framework (Table 1). To better evaluate target student outcomes (Table 1), we adjusted the transactional distance coding theme to differentiate which aspect of transactional distance (communication, flexibility, or course structure) an instructor touched upon in the memory or unexpected benefit survey response. This resulted in six different themes that fit within the target student outcomes for at least one facet of resilience (Table 1). For each theme assigned to the framework (Table 1), we used nonparametric statistical tests to identify significant differences between instructors with various levels of exposure to online teaching. We used the Mann-Whitney-Wilcoxon test in R v. 3.6.0 to compare 1) instructors with and without experience teaching online and 2) instructors who did and did not receive training in online teaching. We used the Kruskal-Wallis test in R v. 3.6.0 to compare instructors who received training during the transition online, those who received training after the transition, and those who never received training. The Kruskal-Wallis test and its two-group equivalent, the Mann-Whitney-Wilcoxon test, are classic nonparametric tests that are commonly used to analyze nonnormally distributed and ordinal data such as ours (McKnight and Najab, 2010).

Conditional Forest Analysis

We used conditional forest (CF) analysis, a form of classification and regression-tree (CART) analysis, to identify the coding themes (Supplemental Tables 1–3) that varied between faculty groups. CART models can process nonparametric data sets containing both categorical and continuous variables, as well as missing data. A “forest” of decision trees is grown using a series of recursive binary splits to create the most homogenous tree branches. We used CART analysis, because it has been shown to outperform other methods in analyzing survey data, especially when the number of independent variables is large compared with the sample size (Buskirk, 2018). CF analysis has the advantage over other CART methods, because it accounts for covariance, removing the tendency for highly correlated variables to be considered more important by CART models. CF analysis returns a conditional importance score for each candidate predictor variable that can be used to compare predictor variables based on their relative impact on the dependent variable, with values below zero indicating the candidate variable performed too poorly to be considered a predictor (Strobl *et al.*, 2008).

CF analysis was used to identify the coding themes (Supplemental Tables 1–3) that were most polarizing for 1) faculty with and without online teaching experience, 2) faculty who did and did not receive training in online teaching, and 3) whether the training occurred never, during, or after the transition online. For CF analysis, 1000 decision trees were grown with the full set of coding theme variables, and

TABLE 3. A count breakdown of memorable moment types between the major categories of faculty: teaching experience and formal training^a

Category/memory	Positive	Negative	Both	None
Teaching experience				
Experienced	12	8	1	3
Inexperienced	30	19	2	5
Formal training				
Trained	30	13	1	5
Untrained	13	15	2	2

^aDiscrepancies in category totals due to inconsistent survey completion between faculty.

variables with ≤ 0 conditional importance score were removed. CF analysis was conducted with the party package in R v. 3.6.0 (Strobl *et al.*, 2008).

RESULTS

Out of 113 faculty surveyed, 66.67% had never taught online before. The ratio of inexperienced online instructors to those with at least some experience varied across institutions. For example, 50% of community college respondents had never taught online before, while 65% at primarily undergraduate institutions and 85% at research-intensive universities had never taught online before (Supplemental Table 4). At the time of the survey in August 2020, 41% of faculty surveyed still had not received formal training in online teaching. Again, there were disparities across institutions: 33% of community college faculty, 35% of primarily undergraduate institution faculty, and 62% of research-intensive university faculty had received no training (Supplemental Table 4), and 28% of respondents had no prior experience teaching online and had received no formal training.

Of the 83 faculty who described a memorable moment, 52% described a positive moment while 33% described a negative moment (Table 3). A greater proportion of untrained faculty had negative moments (Table 3). For example, a faculty member at a community college who had experience in online teaching, but did not receive training, explained a memorable moment:

Working with a student who was finishing class in her grandmother's iPhone because it's all she had. I was impressed with her dedication. It was a reminder to set reasonable expectations that don't require tons of techno[logy]. (Coding: Negative memory; Includes kindness; Bettered teaching; Transactional distance—flexibility)

Only three faculty shared memorable moments that were both negative and positive. In one such case, a faculty member from a midwestern research-intensive university who had experience in online teaching and received training during the pandemic described a memorable moment:

I offered to set up a special discussion group for students who were healthcare workers who wanted to share their fears/concerns/frustrations. [It was memorable] because of the degree of interest and the outpouring of emotion in the group. I recognized that even online a sense of community and support could be created ... and I didn't need to lead it, but simply facilitate. (Coding: Both positive and negative memory;

Includes kindness; Bettered teaching; Includes sense of belonging; Transactional distance—communication)

Among the 59 faculty who answered the question “What difficulties did you encounter teaching online?,” the most common difficulty coded was losing face-to-face interactions, followed by difficulties related to reducing transactional distance, maintaining student engagement, and using technology (Supplemental Table 5). A faculty member from a midwestern research-intensive university with no experience in online teaching, but who had received training, summarized the array of difficulties that students and instructors faced:

Everything took much longer online. Communicating with students, collecting assignments, grading, posting grades and feedback, and the list goes on. I had a terrible time trying to rewrite these exams. Although I only caught two students cheating, I'm sure there were more. Secondly, my students' difficulties were my difficulties. [...] At least 4 were working at jobs that required 12 hour shifts. One got covid-19 and was in and out of class as the illness came and went in waves. Several had major family responsibilities ranging from jobs (as described), care and tutoring for siblings (in one case a disabled brother). I lost count of how many had family deaths due to Covid; one student lost 4 family members in 2 weeks. (Coding: Negative student behavior; Difficulty with transactional distance—communication; Student hardship)

Among the 59 faculty who answered the question “What unexpected benefit did you encounter teaching online?,” the most common benefit described was an improvement to their teaching (37% of respondents), but 8% could not think of any benefit. In reflecting on unexpected benefits, a faculty member from a midwestern research-intensive university with no experience in online teaching, but who received training, reflected:

Some students shared more in the online space! They had things to say about their changed circumstances, shared things about their families, or their educational goals, or how they were seeing the world. These things weren't about learning content but were about who they were as people. Some students also really liked the asynch[ronicity], some were able to be heard more effectively in the Zoom chat space. Inclusivity looks different/plays out differently online. (Coding: Saw benefit; Heard shy voices; Got to know students better; Improved teaching; Transactional distance—communication and structure)

Pedagogical Resilience Analysis

Each pedagogical resilience facet was found to significantly vary among faculty according to either experience teaching online or training received. Determination, measured with the coding theme of kindness included in a faculty's memorable moment, was significantly different between online training periods (K-W $p = 0.027$). Faculty trained during the online transition were the most likely to describe kindness in their memorable moments (60%), followed by instructors who never received training (31.58%), with instructors trained after the transition showing the least inclination to do so (13.33%). Faculty with prior experience teaching online were marginally more likely than inexperienced faculty to describe kindness in their memorable moments (M-W-W $p = 0.079$; Table 3 and Supplemental Table 6). The theme associated with the student outcomes of determination—reducing transactional distance through communication, did not vary between faculty groups (all $p > 0.214$). Twenty faculty discussed communication in their memorable moments, while only eight discussed communication as an unexpected benefit.

Two endurance themes varied between faculty groups. Faculty with experience teaching online were more likely to include negative student behavior as a difficulty they encountered (M-W-W $p = 0.037$; Table 4). Faculty who did not receive training were also significantly more likely than trained faculty to include maintaining or fostering a sense of community as a difficulty (M-W-W $p = 0.008$; Table 4). The theme associated with the student outcomes of endurance—experiencing any difficulties reducing transactional distance, did not vary between faculty groups (all $p \geq 0.654$). The most frequently cited aspect of transactional distance that faculty experienced difficulties with was course structure ($n = 19$), followed by communication ($n = 10$) and flexibility ($n = 1$).

Two adaptability themes varied between faculty groups. Faculty without experience teaching online were marginally more likely to include learning or refining a technology skill as an unexpected benefit (M-W-W $p = 0.059$). Faculty who did not receive formal training in online teaching were almost three times more likely to include the transactional distance aspects of flexibility or course structure as an unexpected benefit (M-W-W $p = 0.061$; Table 4). Almost half of untrained faculty discussed flexibility ($n = 3$), communication ($n = 4$), or course structure ($n = 4$), while only 17% of trained faculty discussed communication ($n = 4$) or course structure ($n = 4$).

Two recovery themes varied between faculty groups. Faculty without experience teaching online were significantly more likely to observe an unexpected benefit (M-W-W $p = 0.023$; Table 4). Untrained faculty were more than twice as likely to include an aspect of transactional distance theory as an unexpected benefit compared with trained faculty (M-W-W $p = 0.022$; Table 4). Eight faculty (four trained and four untrained) discussed course structure as an unexpected benefit, and three faculty (all untrained) discussed flexibility.

Conditional Forest Analysis

The coding variables that differentiated instructors with and without previous online teaching experience were, in order of highest to lowest conditional importance score: “Memorable moment included act of kindness,” “Difficulty: student behavior,” and “Benefit: learned/refined technology skill” (Figure 1).

Faculty with experience teaching online were almost twice as likely to describe an act of kindness in their memorable moments (52.94% of experienced faculty vs. 27.78% of inexperienced faculty) and were almost three times more likely to list student behavior as a difficulty (42.11% of experienced faculty vs. 16.22% of inexperienced faculty). Faculty without previous experience teaching online were more than three times more likely to include learning or refining a technology skill as an unexpected benefit (34.21% of inexperienced faculty vs. 10.53% of experienced faculty).

The coding variables that differentiated instructors who received training in online teaching from those who never received training were, in order of highest to lowest conditional importance score: “Benefit included aspect of transactional distance theory,” “Difficulty: student engagement,” “Type of memorable moment,” “How the memorable moment changed the faculty's outlook,” and “Benefit: learned/refined technology skill” (Figure 2). Instructors who never received training were more than twice as likely to describe an aspect of transactional distance as an unexpected benefit (45.45% of nontrained faculty vs. 17.14% of trained faculty) and were the only instructors to report student engagement as a difficulty (40% of nontrained faculty vs. 0% of trained faculty). Faculty who received training were more likely to describe a positive memorable moment (70.59% of trained vs. 52.63% of nontrained) and were half as likely to describe a negative moment (14.71% of trained vs. 36.85% of nontrained). While faculty who did not receive training were more likely to feel their memorable moments had bettered them by improving their experience and helping them be more effective instructors (73.68% of nontrained vs. 59.38% of trained), they were also the only faculty who were discouraged as instructors by their memorable moments (15.79% of nontrained vs. 0% of trained). Faculty who never received training were more likely to report learning or refining a technological skill as an unexpected benefit (31.82% of nontrained vs. 22.86% of trained).

The coding variables that differentiated when instructors received training in online teaching were, in order of highest to lowest conditional importance score: “How the memorable moment changed the faculty's outlook,” “Memorable moment included act of kindness,” “Benefit included aspect of transactional distance theory,” and “Type of memorable moment” (Figure 3). Faculty who were trained after the transition to online teaching were the least likely to feel their memorable moment had bettered their experience or online teaching (40% after vs. 73.33% during vs. 73.68% nontrained). Faculty who were trained during the transition were the most likely to describe an act of kindness in their memorable moment (60% during vs. 13.33% after vs. 31.58% nontrained). Faculty who never received training were the most likely to describe an aspect of transactional distance as an unexpected benefit (45.45% nontrained vs. 20% during vs. 6.25% after). Faculty who were trained after the transition online were the most likely to describe a positive memorable moment (80% after vs. 66.67% during vs. 52.63% nontrained), but this group also had a higher percentage of negative memorable moments than faculty trained during the transition (13.33% after vs. 6.67% during). Interestingly, faculty trained during the transition were the most likely to describe a nuanced, bittersweet moment that included both positive and negative aspects (20% during vs. 5.26% nontrained vs. 0% after).

TABLE 4. Coding themes assigned to the four facets of adult personal resilience and their statistical significance and marginally significant results from Mann-Whitney-Wilcoxon and Kruskal-Wallis tests

Resilience facet	Coding theme	Statistically significant results ^a
Determination—academic manifestation	Memorable moment: included increased or purposeful kindness	Training period $p = 0.027$ Coded “yes”
		<ul style="list-style-type: none"> • 60% trained during • 31.58% not trained • 13.33% trained after
		Teaching experience $p = 0.079$ Coded “yes”
		<ul style="list-style-type: none"> • 52.94% with experience • 27.78% without
	Memorable moment: included sense of belonging	All $p \geq 0.423$
Determination—student outcomes	Memorable moment: type of moment is positive	All $p \geq 0.135$
	Benefit: got to know students	All $p \geq 0.107$
	Benefit: heard from shy voices	All $p \geq 0.615$
	Memorable moment: included communication aspect of TD	All $p \geq 0.737$
	Benefit: included communication aspect of TD	All $p \geq 0.215$
Endurance—academic manifestation	Difficulty: losing face-to-face interactions	All $p \geq 0.499$
	Difficulty: student access to Internet or technology	All $p \geq 0.323$
	Difficulty: technology for instructors	All $p \geq 0.136$
	Difficulty: time management or drain	All $p \geq 0.162$
	Difficulty: student engagement	All $p \geq 0.309$
	Difficulty: negative student behavior/attitude	Teaching experience $p = 0.037$ Coded “yes”
Endurance—student outcomes	Difficulty: sense of community	<ul style="list-style-type: none"> • 42.11% with experience • 16.22% without
		Training $p = 0.008$ Coded “yes”
		19.05% not trained
		0% trained
Adaptability—academic manifestation	Difficulty: student hardship	All $p \geq 0.146$
	Difficulty: any aspect of TD	All $p \geq 0.654$
Adaptability—student outcomes	Memorable moment: elicited change for the instructor	All $p \geq 0.174$
	Benefit: faculty learned/refined technology skill	Teaching experience $p = 0.059$ Coded “yes”
		<ul style="list-style-type: none"> • 34.21% without • 10.53% with experience
Recovery—academic manifestation	Benefit: improved teaching	All $p \geq 0.226$
	Benefit: got to know students	All $p \geq 0.107$
	Memorable moment: included flexibility or structure aspects of TD	All $p \geq 0.331$
Recovery—student outcomes	Benefit: included flexibility or structure aspects of TD	Training $p = 0.061$ Coded “yes”
		<ul style="list-style-type: none"> • 31.82% not trained • 11.43% trained
	Memorable moment: elicited change	All $p \geq 0.135$
Recovery—academic manifestation	Benefit: observed an unexpected benefit	Teaching experience $p = 0.023$ Coded “yes”
		<ul style="list-style-type: none"> • 97.37% without • 78.95% with experience
	Benefit: improved teaching	All $p \geq 0.226$
Recovery—student outcomes	Difficulty: low rate of TD difficulties	All $p \geq 0.654$
	Benefit: high rate of TD benefits	Training $p = 0.022$ Coded “yes”
		<ul style="list-style-type: none"> • 45.45% not trained • 17.14% trained
	Memory: high rate of TD memories	All $p \geq 0.324$

^aFor statistically significant and marginally significant results, the percentage of faculty from each group (teaching experience, training, or training period) who were coded positively are listed beneath the p value.

DISCUSSION

We found that ERT experiences differed between faculty with and without online teaching experience, as well as between faculty with varying exposure to training in online teaching. We also found that pedagogical resilience and the difficulties fac-

ulty had to endure differed between these groups, which highlights the proposition that personal reflections on ERT should not be treated as monolithic. At the same time, more than 40% of our survey respondents never received training, and our results can help shape future professional development to

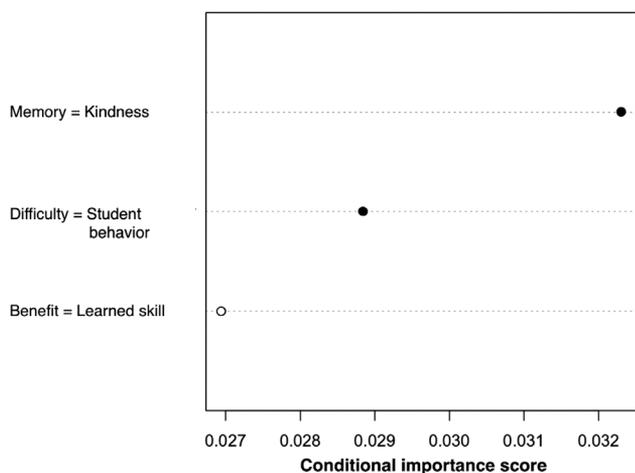


FIGURE 1. CF analysis variable importance for previous online teaching experience. Variables for which a higher percentage of faculty with previous online teaching experience were positively coded are indicated with black circles. Variables in which a higher percentage of faculty without previous online teaching experience were positively coded are indicated with white circles. The relative importance, rather than absolute score values, should be interpreted for CF analysis (Strobl et al., 2008).

be inclusive for faculty across a wide range of individual experiences.

Pedagogical Resilience

Each pedagogical resilience facet was found to significantly vary between faculty according to both experience teaching online and training received. As outlined in our theoretical framework, *determination* is academically manifested by

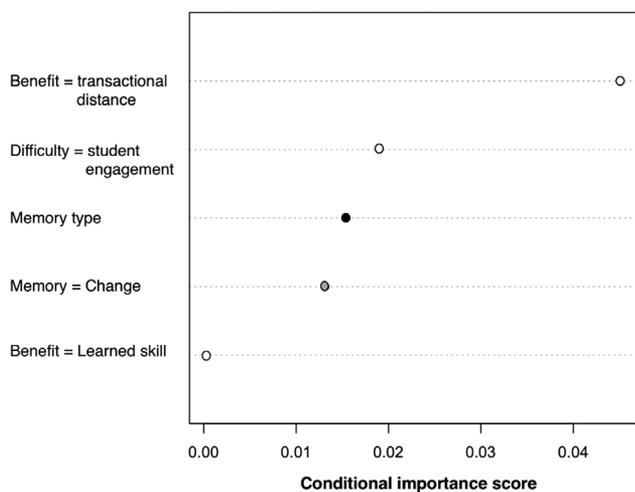


FIGURE 2. CF analysis variable importance for training in online teaching. Variables for which a higher percentage of trained faculty were positively coded are indicated with black circles. Variables in which a higher percentage of nontrained faculty were positively coded are indicated with white circles. Variables with mixed results are indicated with gray circles. The relative importance, rather than absolute score values, should be interpreted for CF analysis (Strobl et al., 2008).

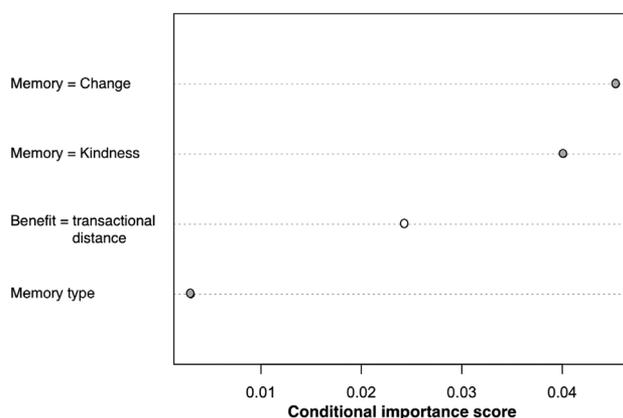


FIGURE 3. CF analysis variable importance for when instructors received training in online teaching (during, after, or never). Variables for which a higher percentage of nontrained faculty were positively coded are indicated with white circles. Variables with mixed results for faculty trained during or after the transition to online teaching are indicated with gray circles. The relative importance, rather than absolute score values, should be interpreted for CF analysis (Strobl et al., 2008).

boosting class morale. Faculty trained during the emergency transition to online teaching demonstrated more determination than faculty without training and faculty trained after the transition, based on including acts of kindness in their memorable moments. Based on this same memorable moment coding theme, faculty with previous experience teaching online were also slightly more determined than inexperienced faculty. These results suggest that having previous online teaching experience or receiving training during the emergency transition afforded instructors a greater cognitive ability to attend to positive behavior in the class. However, based on the coding theme of communication used to reduce transactional distance, there was no difference in determination for student outcomes.

As outlined in our theoretical framework, *endurance* is academically manifested by cognitively enduring adverse situations. Faculty with experience teaching online were more likely to struggle with endurance through difficulty with negative student behavior. We postulate that experienced online faculty may have set higher, less reasonable expectations for students based on their previous experience with traditional online teaching, despite the unprecedented circumstances of the pandemic. In-depth interviews with faculty of various experience levels could examine this hypothesis in more meaningful detail. Additionally, faculty who never received training were the only faculty to struggle with endurance via difficulty maintaining or fostering a sense of community in their courses. However, across nine difficulty coding themes, seven of the themes did not differ between faculty groups (Table 4), demonstrating faculty had to endure many of the same obstacles. Therefore, regardless of online pedagogical background, faculty struggled with many issues including reducing transactional distance for their students, especially through the online course structure, during the COVID-19 ERT. Although two of the difficulties varied between faculty groups, the endurance results also highlight the shared difficulties during an emergency and should be used to encourage departments to make training easily available to

all faculty, regardless of their previous exposure to online teaching.

As outlined in our theoretical framework, *adaptability* is academically manifested through changing teaching behaviors to better suit adverse conditions. Faculty without previous experience teaching online demonstrated more adaptability than experienced faculty, as measured by learning or refining a technology skill. This may partially be due to a ceiling effect, in which instructors with experience teaching online used software and equipment with which they were already familiar. Based on the theme of flexibility or course structure used to reduce transactional distance, untrained faculty demonstrated increased adaptability for student outcomes when describing an unexpected benefit.

As outlined in our theoretical framework, *recovery* is academically manifested through reflecting on the crisis and learning from it. Faculty without previous experience teaching online demonstrated greater recovery, as measured by observing an unexpected benefit from ERT. This may partially be because inexperienced faculty were encountering a teaching modality they otherwise would not have ever experienced, but it may also be because of the burden placed on experienced faculty to help their less experienced colleagues (e.g., Holton 2020). Based on the coding themes related to any aspect of transactional distance, faculty who did not receive training demonstrated greater recovery for student outcomes based on the unexpected benefits they observed. This demonstrates that, even without receiving formal training, faculty were identifying pedagogical upsides to teaching remotely during an emergency.

Here, we evaluated whether faculty with exposure to online teaching, either through training or previous teaching experience, would show more pedagogical resilience during an ERT event. Results from the determination facet suggest faculty who had previous online teaching experience or who were trained during the remote transition had a greater academic manifestation of resilience, but this did not carry over to the student outcome of increased communication. The endurance facet of resilience showed mixed results, with experienced online teachers struggling more with negative student behavior, while untrained faculty were the only instructors to struggle to foster a sense of community in their online classrooms. Most difficulties, including the student outcome of reducing transactional distance, were shared across faculty groups, suggesting endurance is a resilience facet that does not discriminate between online exposure levels. Interestingly, results from the adaptability and recovery facets show more pedagogical resilience in faculty with less exposure to online teaching. Faculty without online teaching experience demonstrated higher academic manifestation levels of adaptability and recovery, while untrained faculty demonstrated greater student outcomes related to flexibility and course structure and overall reduction of transactional distance.

We predicted faculty with more exposure to online teaching through experience or training would demonstrate greater resilience. Our results suggest instead that different online exposure groups exhibited strength in different pedagogical resilience facets. The shared endurance underlines the utility that ERT workshops could have for all instructors. Typically, faculty with pedagogical training are those who prioritize improvement, see

professional development as an asset, and regularly choose to attend optional training (Steinert *et al.*, 2010). Therefore, there is an aspect of self-selection that may have benefited faculty who already saw the benefit of training, increasing their likelihood to receive training, and potentially leading to a mindset that contributed to their resilience. Our participants likely included some faculty with great familiarity with research-based pedagogy, because our survey solicitation included two disciplined-based education Listservs. If experienced faculty were not negatively impacted by ERT, they may not have felt they needed to adapt to or recover skills within a system with which they were already comfortable. Moving forward, we recommend developing a pedagogical resilience scale that can measure both the level of disruption and achievement of each of the resilience facets (Table 1).

Limitations

While there is an urgent need to understand the stressors involved in a general shift to distance learning in a time of crisis, there are also certain subsets of faculty participation that warrant greater study because of the unique challenges they face. At least 300 academic institutions reported hiring freezes, and non-tenure track faculty faced the real possibilities of furlough and contract expiration (Wong, 2020). Furthermore, the rapid shutdown measures to stem the spread of coronavirus transformed homes into offices, lecture halls, day cares, homeschooled, and sick bays. In academia, this transformation disproportionately impacted the research output of women for many reasons. Women were more likely to take on childcare, tending to the ill, and greater teaching responsibilities (Vigilione, 2020). Additionally, Black and Hispanic faculty may have been at a greater level of stress because of the disproportionately high rates of infection, hospitalization, and death within their communities (Garg *et al.*, 2020; Kirby, 2020). Because of COVID-19's disproportionate impact on faculty of color and female faculty, as well as the economic decisions to reduce overall non-tenure track faculty, it is crucial that we understand faculty mindsets during this crisis and identify professional stressors that can be ameliorated with institutional interventions. Unfortunately, our faculty survey did not include demographic questions, and thus our results do not shed light on the experiences of ERT specifically for female faculty, Black faculty, or Hispanic faculty, a topic that should be researched in the future.

While we observed variation in the percentage of faculty with previous online experience across institution types, we did not collect data on instructional identity to better understand this variance. For example, teaching faculty, adjunct professors, and junior faculty may be more likely to be required by their departments to teach online than tenured faculty. In addition, because we solicited participation from both biology and disciplined-based education research Listservs, our survey respondents likely included those with significant experience or even expertise in pedagogy and research-based effective teaching practices. Therefore, our sample may be skewed toward higher online teaching experience and training than in general biology academia.

Our survey only asked faculty whether they received formal training and left the term “formal training” up to the survey respondent’s interpretation. Some faculty may have received quality training in online pedagogy by chatting with their peers

or independently watching videos. Faculty may have assumed that a departmental seminar did not qualify as formal training, because it was not an institutional workshop. Despite the variance that may arise without a strict definition of “formal training,” we believe our survey results are still informative, and that a faculty member’s interpretation of lacking “formal training” would suggest a lack of institutional support or lack of a department making it clear that a seminar is meant to be training.

Polarizing Coding Themes

Faculty with experience teaching online were more likely to describe acts of kindness in their memorable moments, but also were more likely to include student behavior as a difficulty they encountered teaching online during the COVID-19 pandemic, suggesting that experienced instructors were more attuned to both negative and positive behaviors of students. Experienced instructors’ focus on kindness may be due to lower stress levels, allowing them more cognitive freedom to focus on the positive aspects in their memories (Weinstein and Ryan, 2011). One reason that experienced instructors may have had more difficulty with student behavior is because they knew what to expect from standard online participation, and this was not mirrored in ERT (Wester *et al.*, 2021). Unsurprisingly, faculty without experience teaching online were more likely to report that learning or refining a technology skill was an unexpected benefit, because experienced online instructors are likely to be familiar and comfortable with the software and skills necessary for teaching online.

Faculty who received training in online teaching, especially after the transition online, were more likely to describe a positive memorable moment and less likely to describe a negative moment. Because humans typically fixate on negative memories (Kensinger, 2009), this suggests the overall ERT experience for faculty who received training had fewer impactful negative moments. This is supported by the observation that untrained faculty were the only faculty to be discouraged by their memorable moments. Faculty who were trained during the transition were the most likely to describe an act of kindness in their memorable moments and were the most likely to describe a bittersweet memorable moment. This suggests that receiving formal support from their departments or institutions during the emergency transition online made faculty more aware of the myriad of nonacademic issues facing students.

Untrained faculty had the highest percentage of respondents whose memorable moments made them better instructors, and who saw unexpected benefits linked to transactional distance theory and to learning a technology skill. These results could be due to a ceiling effect, in that untrained faculty had fewer online pedagogy skills, increasing the likelihood that they would discover a benefit in the first term of COVID-19. These results confirm that untrained instructors were able to learn as they taught online, despite the lack of formal training. While this demonstrates proactive behavior to help improve ERT instruction in future semesters, untrained faculty were also the only instructors who had difficulty with student engagement. This is a worrying result, because student engagement is positively correlated with academic performance and STEM (science, technology, engineering, and mathematics) retention, and student engagement suffered after the transition online due to COVID-19 (Rocca, 2010; PCAST, 2012; Wester *et al.*, 2021).

CONCLUSION

We found that the onset of ERT had varying impacts on faculty. In some cases, they had no memorable moments they could recall, and no difficulties came to mind. But for other faculty, the stark reality of the pandemic was laid bare to them in their interactions with their students. Faculty recalled socioeconomic, technological, mental, and health issues that their students were facing, along with grief. Faculty found themselves making deeper, and more personal connections with their students. In some ways, faculty were serving a role similar to a social worker by helping students find the resources and support they needed. These recollections of nonacademic interactions demonstrate that, in addition to pedagogical training, higher education should also promote crisis-specific training (e.g., Dragisich 2020) to increase faculty awareness of the resources available to help support students in need during ERT events.

Our results indicate faculty who received formal training in online education had a more positive ERT experience. Faculty who never received training struggled more with student engagement and promoting a sense of community. Given the positive impacts that training had on the faculty we surveyed, it is alarming that more than 40% of our respondents were still untrained as of August 2020. With climate change leading to more natural disasters (Banholzer *et al.*, 2014), and epidemics predicted to become more frequent (Bedford *et al.*, 2019), faculty need the training and tools to seamlessly transition courses from in person to online before future problems develop rather than attempting to fix the issues in the midst of a crisis. We identified nine areas of difficulty that professional development experts should prioritize in future training (Table 4). These include student Internet access, time management, and reducing transactional distance. For faculty with previous experience teaching online, addressing negative student behavior and adjusting expectations during times of crisis should be prioritized in their training. For faculty without previous experience teaching online, learning and refining necessary technological skills should be prioritized in their training. Additionally, our results suggest that some form of training should take place during the emergency transition, because the institutional support may have promoted faculty awareness of students’ nonacademic issues. However, faculty who received training after the transition were the most likely to describe a positive memory, indicating that it is never too late for training to be impactful.

ACKNOWLEDGMENTS

We would like to thank the Donald Danforth Plant Science Center for financial support of this work. We would like to thank Durin Booth, as well as two anonymous reviewers and the editor for their comments and feedback, which helped improve this article. We would also like to thank all the biology education instructors who dedicated their time to participate in a voluntary survey.

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