



Teaching during COVID-19 Times: A Community College Perspective

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In March 2020, the COVID-19 pandemic altered instructional and learning strategies at institutions across the globe. This emergency transition to remote instruction (ETRI) resulted in ambiguity regarding what to teach, how to teach, and instructor/student workload. We report on a survey-based study of 44 community college (CC) faculty at 16 institutions, with the aim of documenting how our CC faculty colleagues perceived the ETRI, the challenges they faced, and the resources that were—or would have been—most helpful. We conclude with recommendations, in the words of participating faculty, to address prevailing concerns voiced by these instructors: namely, the lack of student-faculty interactions in the online space, concerns about student access to resources, and the demand for authentic research and lab experiences.

INTRODUCTION

In March 2020, the COVID-19 pandemic required educators and students to “move online” (1), altering instructional and learning strategies at institutions across the globe. This emergency transition to remote instruction (ETRI, as opposed to pre-meditated, student-selected online instruction) resulted in ambiguity regarding what to teach, how to teach, and instructor and student workload (2). The ETRI also raised concerns that virtual learning may exacerbate pre-existing inequities associated with technology access, financial stability, and familial obligations, among other stressors. Despite disagreements regarding best practices and the deficiencies of remote learning (3, 4), institutions quickly implemented, and continue to evolve, emergency modes of remote instruction (5). While higher-education faculty and administrators plan for further online or hybrid instruction as the COVID-19 pandemic continues, it is important that we understand how the ETRI has affected faculty and student perspectives of teaching and learning.

Initial work addressing the ETRI (6, 7) has mostly focused on large research institutions, reflecting a general trend in the higher-education literature (8, 9). However, there have been fewer studies at smaller colleges, including

community colleges, even though they serve a diverse student body and provide a quality education to nontraditional students, playing a critical role in training future professionals, including scientists (8, 10). In fact, 41% of all undergraduates in the United States attend community colleges (CCs). Additionally, 57% of Native American, 52% Latinx, 42% Black, and 6% Asian/Pacific Island undergraduate students are enrolled in CCs, making CCs especially important for students from diverse racial and ethnic backgrounds (11). Moreover, CCs enroll high numbers of low-income and first-generation college students (11).

Community colleges are especially critical for preparing students for the STEM workforce. Current estimates suggest that 92% of STEM workers require post-secondary education (12). Further, over half of all students pursuing bachelor's degrees in STEM enroll at some point in CCs (13). However, recent reports (8, 9) have documented how, despite the importance of CCs in higher education, there is a paucity of STEM education literature from CC faculty focused on CC experiences. For example, Thompson et al. (8) analyzed 149 articles from three biology education research journals (*JMBE*, *CBE Life Science Education*, and *CourseSource*) over a 3-year period. They found that only three of these studies (2%) focused on CC populations, and the overwhelming majority (85%) were from large, research-intensive universities.

In addition to serving a more diverse student body than that of many large research institutions, CC faculty may employ more inclusive teaching practices than their colleagues at other institution types. Relative to large research institutions, CCs typically have smaller class sizes. And class size alone can lead to more equitable STEM education (14, 15). For example, smaller

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class sizes facilitate close instructor-student relationships, which contribute to a student's sense of belonging and subsequent retention (16, 17). These faculty-initiated positive student-faculty relationships can be especially beneficial to the success of under-represented minority students (18). But the ETRI, with the associated challenge of building relationships during online instruction (19), may disrupt an instructor's ability to develop these relationships.

In sum, by neglecting the important role of community colleges during the ETRI, the experiences of a substantial number of students and faculty are omitted from critical discourse about how best to serve our nation's college students during the pandemic. As faculty members from four CCs and one research university, and one aspiring CC faculty member, we represent two networks—EDU-STEM (8) and CCURI (20)—that aim to promote CC students and faculty in the STEM-education literature. Our own experiences led us to question how our CC faculty colleagues perceived the ETRI, the challenges they faced, and the resources that were—or would have been—most helpful. Through a networks-distributed survey of CC faculty, we were able to address the following research questions (RQs):

RQ1: How did faculty perceive online teaching and learning: a) before, b) during, and c) after the ETRI?

RQ2: What were the most positive outcomes of the ETRI?

RQ3: What were the biggest challenges faculty faced during the ETRI?

RQ4: What solutions did faculty report, in response to the challenges from RQ3?

METHODS

Study participants

We surveyed faculty at 16 community colleges distributed throughout the United States and belonging to the Community College Undergraduate Research Initiative (CCURI [20]) and/or the Equity and Diversity in Undergraduate STEM (EDU-STEM [8]) networks.

Survey instrument and distribution

Community college contacts, in the EDU-STEM and CCURI networks, were emailed in May 2020, at or close to the conclusion of the Spring term and after the transition to remote instruction and asked to participate in the study. The first 100 people to complete the survey received a \$5 Starbucks gift card.

The survey was reviewed by the University of Minnesota's Institutional Review Board and was considered exempt from full IRB review (STUDY00002261) due to its low risk and non-invasive nature. Participants were given 2 weeks, and one reminder, to complete the survey. The survey was administered

via Qualtrics, and after an initial page in which the study procedures were fully explained, participants could check a box implying their consent to participate.

Our survey items drew heavily from a survey administered by Ben Motz and colleagues at the University of Indiana—Bloomington (21). The full survey is available as Appendix 1. Some survey items were constrained-choice (with several options, or Likert-scale agreement), and some items were open-ended for further elaboration. The survey included items about past familiarity with remote instruction (e.g., see Appendix 1, Question 15) and specific challenges they faced (e.g., see Appendix 1, Questions 30 and 32). Some items asked the extent to which certain practices (e.g., working on problems with other students, taking online quizzes or exams) applied during the transition (see Appendix 1, Question 22).

Data analysis

For this exploratory study, we analyzed both qualitative and quantitative survey responses ($n = 44$) to address our research questions. Responses were downloaded to Microsoft Excel from Qualtrics and de-identified by a researcher unaffiliated with the present study. We removed incomplete de-identified responses and those of faculty who indicated they did not experience the ETRI. Likert-scale responses were analyzed categorically and visualized as relative frequency distributions. For ease of interpretation in the written results (below), the Strongly Agree and Strongly Disagree Likert-scale responses were collapsed into the Agree and Disagree categories, respectively.

For our qualitative analysis, we analyzed written responses to four survey items: (i) "Please explain how you changed your grading standards or strategies," (ii) "Reflecting on the transition to remote instruction, what was the most negative outcome?," (iii) "Reflecting on the transition to remote instruction, what was the most positive outcome?," and (iv) "What one thing could the Department or Institution have done to improve your experience after the transition?." Using a two-cycle analysis (22), two researchers first independently coded faculty responses using *in vivo* coding. Then, they used the cutting and sorting technique of Ryan and Bernard (23) to generate consensus categories, whereby researchers initially scanned all faculty responses and then identified similarities, differences, and repetition of key words and phrases (24). Researchers met to define themes and consensus codes. Consensus categories are described for each item in Appendices 2 to 5.

RESULTS

Forty-four faculty members, from 16 institutions, participated in the survey. Of these, 66% were tenured, 7% were pre-tenure, and 27% were non-tenure track (e.g., adjunct faculty). On average, they had 16.4 ± 7.4 (mean $\pm$ SD) years of postsecondary teaching experience. Specific results, below, combine findings

from both constrained-choice (quantitative) and open-ended (qualitative) survey responses. All percentages are rounded to the nearest whole number for simplicity.

RQ1a: How did faculty perceive online teaching and learning before COVID-19?

Before the ETRI, faculty were generally accepting of online teaching technology and practices, though online teaching did not necessarily align with their identities. Over 70% of faculty indicated that they were familiar with technology and strategies for online teaching and learning (Table 1). A vast majority also indicated that they were “comfortable” (41%) or “very comfortable” (34%) adopting new technology in their classrooms; fewer indicated that they were “neutral” (16%), “uncomfortable” (7%), or “very uncomfortable” (2%). Despite this widespread support for online teaching and learning, ~18% of faculty had resisted learning about online teaching and learning and 41% of faculty indicated that online teaching and learning conflicted with their personal identity as instructors (Table 1).

RQ1b: How did faculty perceive online teaching and learning during COVID-19?

When the ETRI began in the first weeks of the Spring semester, 93% of faculty were mandated to transition their courses online. The majority of faculty surveyed (61%) were “experienced” with remote instruction, having taught more than one course completely online. A large proportion of faculty surveyed (39%) were new to remote instruction, yet 88% of these “novices” had taught the course that transitioned at least twice before “in-person” (Table 2).

The majority of faculty (61%) indicated that their college offered them sufficient resources for online teaching (Table 1). This sentiment was a little lower at the departmental level, with 53% agreeing that the department offered them sufficient resources for online teaching. Overall, faculty knew where to go for technical and instructional support (92% and 74%, respectively), and they obtained sufficient resources to teach during the ETRI (79%) (Table 1).

Many individuals altered their assessments during the ETRI, with changes that reflect a general transition from collaborative to individual assignments. For example, 13% of respondents indicated they eliminated group projects and/or individual assignments and restructured course assessments (e.g., shortened assignments, added individual projects, transitioned to online quizzes). Faculty members also incorporated flexibility into quizzes and assignments by allowing for multiple attempts on quizzes, keeping deadlines flexible, lowering expectations, and adjusting to be more lenient in their grading. A minority of faculty (3%) reported that they focused more on formative assessment, eliminated exams or quizzes, transitioned to a pass/fail grading system, and spent less time on grading. One instructor noted that “[q]uizzes were worth less percentage of total grade and

homework was worth more.” And another elaborated, “I changed the grading so that there were many more small assignments and the emphasis on testing was reduced because I am fairly sure my students are cheating on the quizzes I give.” Over 75% of faculty reported that they would have liked to include collaborative projects, group discussions, live video meetings, practice questions, collaborative writing assignments, and/or online labs/simulations but were primarily limited from doing so by a concern of overburdening students, a lack of time, and a lack of technology.

Despite successfully adapting their teaching strategies, faculty still struggled to maintain motivation, productivity, and a quality learning experience for students. Specifically, 66% of faculty members found it more difficult to teach during the ETRI and 39% indicated that they had less motivation to teach. Sixty percent indicated that productivity in non-teaching aspects of their job (e.g., engaging in professional development, serving on committees) decreased, suggesting an overall decrease in productivity during the ETRI (Table 1).

In addition, respondents indicated concern for student well-being: 80% of the instructors thought that students needed more academic support, 94% thought that students needed motivational support, and 87% were concerned about student mental health (Table 1). Further, faculty members consistently reported a loss of student-faculty interaction during the ETRI: 81% felt disconnected from students, but 42% found new ways of interacting with students, and 73% felt it was difficult to keep track of students. In open-ended comments, some faculty (3%) reported that students “fell through the cracks.” Finally, 51% of faculty members thought that, while learning objectives remained important, students received a lower quality learning experience than they would under “normal” instruction. One respondent said, “The external non-school pressures on the students caused some great students to do poorly and those needs were out of their control.” And the following comment represented sentiments shared by the majority of faculty:

“I feel the transition in general was much harder for students than faculty. Students were fine with the technology of distance learning (minus spotty internet access or broken computers, which is largely beyond their control) but struggled with living at home or in the dorm (in the case of many international students), grief over losing the residential college experience they’d often been loving, and shock at seeing the world change and the future become so uncertain. These are true for faculty, too, but most of us live in our own homes and have jobs at least for the moment.”

RQ1c: How did faculty perceive online teaching and learning after COVID-19?

After the ETRI, many faculty members indicated a willingness to pursue hybrid instruction, but they were more divided on the future of online instruction. Specifically, 67%

TABLE I
Summary of responses to 22 survey questions using a 5-point Likert scale

Theme	Survey statement	# of respondents	% Strongly disagree	% Disagree	% Neutral	% Agree	% Strongly agree
Faculty prepn before the ETRI	I was familiar with strategies for online teaching and learning.	39	0.0	7.7	17.9	51.3	23.1
	I was familiar with technology for online teaching and learning.	39	0.0	7.7	15.4	41.0	35.9
	I resisted learning about online teaching and learning.	39	43.6	33.3	5.1	10.3	7.7
	Online teaching conflicted with my personal identity as an instructor.	39	15.4	23.1	20.5	25.6	15.4
Resource availability during the ETRI	I personally felt well-prepared for ETRI.	38	5.3	26.3	21.1	34.2	13.2
	I was able to find sufficient resources for online teaching.	38	0.0	5.3	15.8	57.9	21.1
	I knew where to go for instructional support for online teaching.	38	0.0	10.5	15.8	44.7	28.9
	I knew where to go for technical support for online teaching.	38	0.0	2.6	5.3	50.0	42.1
Faculty productivity and Motivation During the ETRI	I was able to stay true to my original teaching values and objectives.	35	2.9	28.6	11.4	45.7	11.4
	I have become more productive in my other (non-teaching)	35	31.4	28.6	31.4	0.0	8.6
	The time I invested in teaching increased overall.	36	2.8	5.6	11.1	27.8	52.8
	Teaching became a more important aspect of my job.	34	14.7	23.5	52.9	5.9	2.9
Faculty-Student interactions during the ETRI	I was more motivated to teach.	36	8.3	30.6	55.6	5.6	0.0
	It was more difficult to teach.	35	8.6	8.6	17.1	31.4	34.3
	I found new ways of interacting with my students.	36	2.8	19.4	36.1	27.8	13.9
	I worried about my students' mental health.	37	2.9	2.9	8.6	45.7	40.0
Faculty-Student interactions during the ETRI	I felt like my students needed more motivational support.	36	0.0	0.0	5.6	47.2	47.2
	I felt like my students needed more academic support.	36	0.0	5.6	13.9	50.0	30.6
	I felt disconnected from my students.	36	2.8	2.8	13.9	41.7	38.9

Continued on next page

TABLE I (Continued)

Theme	Survey statement	# of respondents	% Strongly disagree	% Disagree	% Neutral	% Agree	% Strongly agree
Long-Term effects of the ETRI	I think students will be very comfortable learning technical subjects through remote instruction in the future.	37	8.1	27.0	43.2	18.9	2.7
	I think my students will struggle in their future coursework or employment because my course(s) had to be offered remotely.	36	2.8	33.3	36.1	25.0	2.8
	Despite the transition to remote instruction, my students will have no disadvantage in their future coursework.	36	5.6	36.1	27.8	30.6	0.0

^aResponses are grouped by theme indicating faculty response to online teaching and learning before, during, and after the ETRI.

of faculty members indicated that they would be more willing to teach a hybrid course after their ETRI experience, while only 50% indicated they are more willing to teach a 100% online course. A sizable proportion (32%) indicated they would *not* be more likely to teach a 100% online course after the ETRI.

Participants voiced uncertainty on the possible effects of the ETRI on students' futures (Table I). Thirty-one percent agree and 42% disagree that the ETRI will disadvantage students in future coursework; 28% agree and 36% disagree that the ETRI will disadvantage future employment; and 22% think students will be very comfortable learning technical subjects via remote instruction in the future.

RQ2: What were the most positive outcomes of the ETRI?

The ETRI demanded faculty develop virtual content, positively contributing to faculty members' experiences during the transition. Four of the top five positive outcomes, identified by faculty through their free responses to Question 31, refer, at least in part, to the development of virtual content. Twenty-two percent of respondents indicated that increasing familiarity with new technology and/or increasing their technical skills was the most positive outcome of the ETRI. 10 percent and 8% indicated that content development and the opportunity to refine or re-structure course content to benefit student learning was the most positive outcome, and 10% of faculty indicated that the ETRI inspired them to use online resources in the future. For example, one individual noted, "I was able to generate a lot of new course materials that will be very useful in face-to-face, hybrid, and online settings in the future. My face-to-face classes will be much enhanced by the work I've done this quarter." And while a large portion of faculty indicated that students were disengaged (see below), student engagement was listed as a positive by 18% of respondents. Some of these respondents referred specifically to increased engagement of students in office hours or virtual communications (e.g., "Students seemed more comfortable asking questions through email" and "Students seemed more open to online office hours"). A few respondents echoed the sentiments of this comment: "Some students that didn't do well in face-to-face instruction are thriving."

RQ3: What were the most negative outcomes of the ETRI?

The most negative outcomes of the ETRI were diverse, with a lack of student-faculty interactions and the lack of authentic lab and research experiences being the most pervasive negative consequences reported. Open-ended survey responses such as "I like interacting with my students in person, and I didn't get to do that," were echoed by 27% of the respondents, identifying a lack of student-faculty interactions as the single most negative outcome of the ETRI.

TABLE 2
Faculty experience teaching online before the ETRI^a

Research question	0	1	2–4	4+
no. of Online Courses Previously Taught	38.6%	13.6%	20.5%	27. %
no. of Times Teaching the Class that Transitioned	10.3%	0.0%	15.4%	74.4%

^aResults are presented as percentages of faculty responding to each question.

Some faculty members (6%) felt that they had lost the ability to immediately gauge student learning (e.g., “Not meeting with students to be able to gauge their comprehension. I was teaching all Microbiology labs, which are very difficult to teach remotely.”). The lack of authentic lab/research experiences was identified as a negative outcome by 24% of faculty. Respondents reported that many labs simply could not be completed, and they felt that online labs did not substitute well for in-person labs.

The logistical and pedagogical difficulties that faculty faced during the ETRI were layered upon a mental health drain. Eighteen percent of faculty identified that they were overworked or that work-life balance suffered, and that this was the most negative outcome of the ETRI. One person wrote about “[t]he drain on myself as an instructor. The immense use of time, the overwhelming and exhausting days that did not end resulted in frustration and lack of sleep.” Another instructor elaborated:

“This is hard—It is still hard. I am working ~70 hours a week, and unable to keep up with it all. I am prioritizing content creation over grading, but that means my students are not getting as much feedback as they normally would. There are days that I am on the computer by 8:30AM and after a 30-minute lunch break and a 2-hour dinner/bedtime break, I am back to work until 1 or 2 in the morning. I have been working 7 days a week since March 23. I spent more time with my computer on Mother’s Day than I spent with my young children. . . and after all of this, I am still not confident that the course that I am creating is of high enough quality that my students will want to return in the Fall to take the next course in the series. Every scheduled meeting fills me with dread, because it is 1, 2, 3, 4 hours that I am not keeping up with my classes, which means more late nights. The only consolation is knowing that a significant portion of my content will already be built for Fall quarter, which we have scheduled to be online lecture (hoping for on-campus labs).”

These comments exemplify the extent to which the ETRI contributed to stress.

Decreased student engagement and inequity between students also contributed to the negative aspects of the faculty experience. About 14% of respondents shared concerns about “[s]tudents not attending meetings remotely. . .”; and “Those [students] who are not doing as well are hard to help because. . . I don’t know how much they are accessing my online materials (if at all). Based on

access reports, it doesn’t seem like a majority who complain about how I’m teaching are [accessing online materials].” Some student disengagement likely came from inequities associated with technology access or the inability of students to adapt to the online learning environment (e.g., “Several students failed or dropped my course because they were uncomfortable with the online format”). One individual noted that “Some students were unable to access the course because of issues with Internet connectivity or computer access. Because of this, or because of other reasons, about ~25% of my class stopped completing assignments part way through the quarter.” And another highlighted the equity gap, stating that “the equity gap has never been so obvious as what I’m seeing when a class goes to 100% online and the resources to help this are nowhere near where they should be.”

RQ4: What solutions did faculty report, in response to the challenges from RQ3?

Many participants voiced concern about being disconnected from their students, and the impact of this loss of student-faculty interactions. In response to this concern, one faculty member commented:

“One of the greatest challenges involved addressing the stressors that many of the students were experiencing outside of their academic commitments. Many students reported having significant changes in family or employment situations that would prevent them from continuing their education if the transition to online employed a synchronous modality with fixed meeting times. [To] address this challenge, some faculty adopted a “HyFlex” model where students could choose, for each class meeting, how they would like to attend. Students could attend a live WebEx class at the scheduled time the course meets or watch a recording of the class meeting at their convenience. Additional materials were made available on the LMS to offer guidance to students who could not attend the live session. This solution worked to maximize the amount of direct interaction with students, while at the same time creating flexibility for non-traditional students.”

Similarly, one participant reported implementing an optional lecture time and modified office hours to allow for more personal interaction with students enrolled in an asynchronous course:

“The hardest part of the ETRI was the lack of student interaction/engagement because of the increased personal issues brought on by the pandemic. Furthermore, all of our courses were asynchronous. With these factors in mind, I had to find alternative ways to meet with my students. I scheduled a weekly virtual lecture time that was optional so that students had the opportunity to ask questions and get immediate feedback. These sessions were recorded and posted so that all students were able to access the information. These recordings included a transcript of the recording. In the ETRI, I set up a virtual office in WebEx that I used for standing office hours (3 hours per week), and students were able to schedule other office hours that aligned with their schedules. Students appreciated the standing office hours and virtual online lectures, with many of them logging in even if it was just to talk and connect with others. This was a huge time commitment on my part, but it brought me great joy to engage with my students.”

And one contributor explained the use of audio feedback to improve communication with students:

“I adopted the use of the audio feedback option for assignments in our course management system. Specifically, I used the “compliment sandwich style” of giving positive feedback, then a constructive criticism or concern, then personalized encouragement or compliment. This was substantially easier for me than cumbersome typed feedback and also made me feel more personally connected with the students. The students expressed that the audio feedback felt like a personal connection to me and that I cared about them and their success.”

Many faculty expressed concerns about student access to resources, including reliable Internet. Diverse strategies were employed to address these concerns, for example:

“As the semester continued, additional supports were created to address both student and faculty needs related to the new remote instructional environment. A technology loan program was rolled out to ensure that students had access to the equipment they needed to continue their studies, and equipment was installed in college parking areas to provide access to Wi-Fi. Weekly online faculty forums were offered for the purpose of creating a platform for faculty to share challenges and best practices. Faculty also began reaching out to the various disciplinary societies as a way to gain access to supports being developed outside of the college community.”

And many colleges used this opportunity to develop new resources:

“At least one series has adopted an OER textbook and an internal grant was secured to create ancillary materials for the OER textbook. I'm excited to be a part of that grant! I also secured funding from Disability Services to convert all of my slides and ancillaries to meet accessibility and universal design standards. The long-term goal is to replace all publisher images with open access (Creative Commons) images.”

Similarly, a few faculty restructured how they presented their materials to clarify expectations for their students:

“When I pivoted to an online classroom, I developed a more detailed syllabus that clearly stated the weekly assignments/due dates and I embedded clickable links to assignments in the syllabus. This made it easy for students to navigate directly from the syllabus to the assignment. And typically, my course material is organized into topic modules covering the material for each of the exams. These modules include slides, reading guides, exam review questions, and links to multimedia resources. In the ETRI, I reformatted my course into weekly folders within the module folders, and labeled both the module and weekly folders with clear descriptors that listed the weekly assignments with due dates. I had experience organizing my course in this manner because I had used this format previously in my online courses. Students were able to easily navigate through the weekly folders and completed most assignments by the due date.”

DISCUSSION

Overview

In our exploratory study of the perceptions of community college faculty members during the emergency transition to remote instruction, we find general agreement that faculty entered the ETRI familiar and comfortable with online teaching and learning (Tables 1 and 2), a level of comfort possibly reflective of their previous experience with teaching the course, or past experience teaching online (Table 1). The majority of faculty felt they had the necessary resources to transition during the ETRI, but varied in how well prepared they felt, personally—possibly due to some of the psychological burdens they faced in their own lives, and in their concern for the students' well-being (Table 1).

Several factors limit our ability to extrapolate beyond the sample surveyed. For one, this was a convenience sample, based on the network affiliations of the co-authors. No systematic techniques were employed to ensure an even distribution of faculty members based on any category—gender, seniority, region, etc. Further, we are unable to control for the effects of the institution itself on the perceptions of any participant; in our analysis and interpretation, we have largely treated our respondents as one population, rather than 44 individuals arising from 16 different institutions. Further, the core of the survey itself was generated *ad hoc* (21) in response to the ETRI and had not been previously validated beyond think-aloud discussions. Finally, this study focuses on CC faculty, and is not designed to be comparative with the experiences of faculty at different institution types. We cannot address, for example, whether CC faculty, with their incoming experience with online teaching, and explicit focus on teaching, might have differed during

the ETRI from their colleagues at better-resourced, but less teaching-centered, research institutions.

Despite these limitations and based on our results from RQ3 (“What were the most negative outcomes of the ETRI?”), we present a few strategies participating faculty used to counter key documented challenges with online and/or hybrid instruction: lack of student-instructor interactions, lack of access to resources, and lack of authentic research/lab experiences. While we recognize that a large body of literature exists for faculty engaged in truly online education, our intent is to provide suggestions, from CC faculty, for our colleagues seeking solutions for courses that have transitioned to a remote environment in response to the current public-health crisis.

Lack of student-instructor interactions

A primary recommendation for improving interactions is synchronous lectures, which allow students and faculty to see each other in real time. This recommendation was tempered by faculty members concerned about their students without reliable access to computers and Internet, many of whom indicated asynchronous courses as a positive outcome of the ETRI. Given that constraint, a blend of asynchronous and synchronous course elements, with flexibility for students encountering technology disruptions, may be the best strategy (25, 26).

Some faculty members expressed an interest in tools like Flipgrid or social media apps (e.g., Tik Tok; Snapchat) that can also facilitate student-instructor interactions (*viz.* short presentations, reporting on discussions, asking questions, etc.). With Flipgrid (<https://info.flipgrid.com/>), teachers and students can record short videos to share with their peers in response to a given prompt (e.g., “tell us about yourself,” or “describe the hypothesis we’re testing in lab this week.”). Sebach (27) reports that using Flipgrid in lieu of written, post-practicum journal entries was positively perceived by nursing students, who found the tool more engaging than a written assignment, and by their instructors, who used Flipgrid to provide real-time video feedback.

Instructors may also improve student motivation and engagement by using a backchannel, a secondary, digital conversation taking place simultaneously with college lectures (e.g., the chat function in Zoom). These backchannels have been shown to provide a social aspect to classes and increase student engagement (28–33). Specifically, backchannels have been shown to increase the frequency of questions asked and to diversify the demographics of students who ask the questions (34).

Lack of access to resources

Faculty participants shared a variety of strategies to address concerns about access to resources, such as technology loan programs, WiFi in college parking areas, and networking to share free resources. The materials developed by some disciplinary societies have been useful, as has

the increased availability of open-access images and textbooks. Several instructors took advantage of small internal grants to develop new materials in-house. Our hope is that our colleagues will continue to develop, and share, these open instructional resources.

Lack of authentic research and lab experiences

Laboratory education and the acquisition of practical skills that come with it were limited during the ETRI and the barriers (e.g., access to necessary equipment) persist. Given the immediacy of the transition, and the need for triage in adapting to remote instruction, many participants reported that their laboratory exercises suffered the most. Luckily for instructors, there is a trove of free, open-access resources that can be leveraged to provide students with authentic research experiences *in silico*. Some of these online resources, such as the Project EDDIE Teaching Modules (35), the Ocean Observatories Initiative Data Explorations (36), and CourseSource (37) host teaching materials that have been developed to target a range of student levels and learning objectives. These plug-and-play modules may be incorporated into an existing course relatively quickly and easily. Alternatively, faculty may develop their own inquiry-based projects using publicly available data sets. Thompson et al. (8) provides several examples of these data sets (e.g., Long-Term Ecological Research, USGS, and NOAA databases and Zooniverse citizen science projects) as well as a successful strategy for incorporating these data sets into courses during the ETRI.

Finally, at home, do-it-yourself (DIY) labs can promote student creativity and autonomy (38) and lower barriers to participation in lab activities. Critically, we distinguish this recommendation from suggesting students engage in the current “DiY Science” movement, in which non-biologists attempt genetic engineering at home (39). We also reiterate the importance of caution with DIY labs, and refer readers to the ASM Guidelines for Biosafety in Teaching Laboratories (40), specifically those regarding at-home microbiology kits.

The above recommendations are evidence-based (wrought from both previous work and faculty responses in this study) and we hope they will provide faculty with more structure moving forward with remote/hybrid instruction. However, we recognize that their efficacy has yet to be tested empirically during an ETRI and look forward to continued collaborations with community college faculty—via EDU-STEM and other collaborative networks—to test these recommendations.

SUPPLEMENTAL MATERIALS

Appendix 1: Survey instrument

Appendix 2: Emergent themes identified in changes to faculty’s grading standards and/or strategies

Appendix 3: Emergent themes identified as the most negative outcome of the ETRI

Appendix 4: Emergent themes identified as the positive outcome of the ETRI

Appendix 5: Emergent themes identified regarding what colleges could have done to improve the ETRI experience

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