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Engineering Instructors' Self-reported Activities to Support Emergency Remote Teaching During the COVID-19 Pandemic

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Abstract

This Research paper focuses on understanding activities engineering instructors engaged in to facilitate teaching during the initial weeks that the COVID-19 pandemic impacted instruction. Participants, including tenured or tenure-track professors and professors of practice, completed weekly surveys during the last seven weeks of the Spring 2020 semester. An adaptability lens was used to frame this study. Data analysis consisted of descriptive statistics to capture trends in instructors' engagement in various activities to support their teaching and to understand whether engagement in these activities was perceived as being similar to a non-COVID semester. Findings revealed that over the seven weeks, many instructors engaged in teaching themselves something new and casual conversations about teaching. The self-directed and community-based activities instructors reported engaging in during the first two weeks were identified as being atypical compared to a non-COVID semester. Understanding the activities that instructors engaged in during this forced change to emergency remote teaching can help in the identification of resources and supports that enable instructional change during future events.

Introduction

The COVID-19 pandemic presented unparalleled challenges to face-to-face education. With the urgency to control the outbreak, many universities across the nation shuttered campuses, and suspended face-to-face instruction, requiring instructors to transition within a few weeks to remote teaching. As a result, instructors had no choice but to adapt their instructional practices to complete the Spring 2020 semester. The level of instructor adaptation necessary was unprecedented in comparison to decades of efforts to change engineering education through traditional faculty development strategies. The extraordinary response to the COVID-19 mandate brought a unique opportunity to explore engineering instructors' engagement in teaching related activities to facilitate mandatory remote instruction.

Online learning is not a novel phenomenon and has been a major component of higher education for many years across disciplines, including business, education, and criminal justice [1]. However, the change that took place during Spring 2020 was not traditional online instruction but rather an emergency transition to remote teaching. Emergency remote teaching (ERT) is defined as "a temporary shift of instructional delivery to an alternate delivery mode due to crisis circumstances" [2, p. 7]. Emergency remote teaching is distinct from traditional online teaching and learning, in which virtual experiences and online instruction have been planned from the beginning [2, 3]. ERT, in comparison, is enacted in response to a crisis; it entails hasty adjustments to instructional practices and course content to accommodate new instructional modalities, allowing insufficient time for pedagogical planning. In such circumstances, challenges experienced by novice online instructors under normal circumstances are greatly exacerbated because of the abrupt transition [2]. This impact can be even more significant for those instructors and or programs (e.g., engineering) that are not accustomed to remote teaching [3-4]. The lessons learned from ERT can be translated into future change efforts to improve engineering education.

Background

Remote Teaching in Engineering

The sudden shift to ERT due to the COVID-19 pandemic has differentially impacted engineering education where a widespread paradigm shift to remote learning has yet to be seen [4]. The lack of remote teaching in engineering, prior to the pandemic, has been attributed to the inherent nature of the discipline, which requires hands-on training to work with instruments and materials in controlled laboratory settings [5]. Learning experiences that support practical knowledge and skill development are essential for engineers but are difficult to create in a digital environment [5]. Consequently, researchers have claimed that transiting conventional engineering courses that focus on content-centered and designed-oriented learning to online may not provide students with the in-depth learning required in engineering [5-6]. Furthermore, converting conventional engineering courses to remote instruction necessitates instructors' willingness to learn their university's learning management system (LMS) and understand effective instructional practices that facilitate remote teaching and learning. Despite engineering's resistance to remote instruction under normal circumstances, the unexpected global crisis compelled engineering instructors to rapidly adapt. In these peculiar times, instructors' adaptability played a pertinent role in their ability to engage in the situation to meet new demands.

Theoretical Framework: Adaptability

Adaptability is defined as an individual's ability to "constructively regulate psycho behavioral functions in response to new, changing, and/or uncertain circumstances, conditions and situations" [7, p. 66]. The ability to adapt enables an individual to successfully adjust to unexpected circumstances [8]. Thus, adaptability is considered to be a key mental resource and comprises an individual's cognitive, behavioral, and emotional regulation in situations of change, novelty, and uncertainty [7]. Individuals with a high level of adaptability can "reserve more psychological resources than individuals with a low level of adaptability" [13, pp. 1]. In literature, adaptability has been discussed in relation to different phenomena at the individual, team, and organizational levels [9 - 10]. The concept of adaptability has also been employed to understand and explain change in an individual's academic and non-academic well-being [11-12]. A number of studies have also discussed instructors' adaptability as a central factor in effective teaching and learning, particularly in K-12 (e.g., [8, 11, 13]).

In higher education, career change, academic achievement, engagement, and life satisfaction have all been examined through the lens of adaptability. However, many of these studies have explored undergraduate students' adaptability [12, 14-16]. In regard to instructors' adaptability, a study by Holliman *et al*., [17] examined university lecturers' perceived autonomy support (job resource), adaptability, organizational commitment (feeling towards employer/institution), and psychological wellbeing. The authors found that perceived autonomy support was positively associated with lecturers' adaptability, organizational commitment, and psychological wellbeing. Mardiana [18] investigated Indonesian instructors' adaptability to technological change and its impact on the teaching process in the context of online teaching. The findings of this study revealed instructors' adaptability (improving, easy life, belief, ability and skillful, and training) was positively correlated with technological change (use of technology in teaching, use of

internet and social media, sharing and contributing to content, digital literacy, and learning from others on the internet).

The studies discussed reinforce that adaptability is a theoretical construct that is pertinent to the current situation. Using adaptability as the theoretical framework to study engineering instructors' ability to adapt to ERT may lead to new insights about how to support future instructional change. As indicated earlier, Martin *et al*., [7] modeled adaptability along three different dimensions: cognitive, behavioral, and emotional. According to this model, determining how a person responds to change by analyzing their thinking, behavior, and emotions can provide insight into their level of adaptability. This study focuses on instructor behaviors, which were operationalized as two kinds of teaching-related activities - engagement in learning new things related to teaching and engagement with their community.

Research Purpose & Question

The purpose of this study is to explore instructors' self-reported engagement in teaching related activities and self-assessment of the normality of these activities (as compared to non-COVID times) during the initial months of the crisis. This study is part of a larger study [19]. The research question addressed in this work is: *What teaching related activities did instructors engage in to support course delivery during a forced transition from face-to-face to remote instruction?*

Methods

Participants & Setting

The participants were engineering instructors at a R1 university in the U.S. Midwest. Instructors teaching in Spring 2020 were invited to participate in the study. A total of 57 instructors (out of 161) volunteered to participate in the larger study. However, in this study, only data from tenured or tenure-track professors and professors of practice (n = 39) were included (Table 1). The majority of participants were male (74.4%) and tenured or tenure-track professors with teaching/research appointments (69.2%). Many of the participants (25.6%) were from Civil and Environmental Engineering, and there was an equal number of instructors that participated from Biological Systems Engineering, Computer Science & Engineering, and Mechanical & Materials Engineering (17.9%).

Survey Instrument

Weekly online surveys were constructed to probe participants' teaching-related activities during the last seven weeks of the Spring 2020 semester (April-May). The first five surveys were completed in weeks 12 to 16, which was the period following the transition to remote teaching. The last two surveys were completed at the end of the semester (Finals Week) and after grades were submitted (Grades). The surveys consisted of multiple-select, multiple-choice, and opened-ended items. The Cronbach's alpha coefficient was calculated for survey reliability, which yielded an alpha coefficient of 0.83, indicating a high level of internal consistency.

Table 1. Engineering Instructor Participants Demographic Characteristics (*n*=39)

Category	Subgroup	*n*	%
Gender	Male	29	74.4%
	Female	10	25.6%
Position	Assistant Tenure-Track Professor	12	30.8%
	Associate and Full Professor	15	38.4%
	Assistant Tenure-Track Professor of Practice	9	23.1%
	Associate and Full Professor of Practice	3	7.7%
Department	Architectural & Construction Engineering	4	10.3%
	Biological Systems Engineering	7	17.9%
	Civil & Environmental Engineering	10	25.6%
	Computer Science & Engineering	7	17.9%
	Mechanical & Materials Engineering	7	17.9%
	Other*	7	10.2%

**Chemical & Biomolecular Engineering and Electrical & Computer Engineering departments were combined to ensure confidentiality due to low participation rates.*

This study is an analysis of participants' responses to one multiple-select and multiple-choice pair of items over the seven-week period. For these items, instructors were first asked to identify which of 10 activities or none of the above (Table 2) they had engaged in during the past week. While not differentiated for the participants, the ten activities were conceived as being divided into two categories, *self-directed activities* and *community-based activities.* Self-directed activities refer to engagement in learning about teaching to support oneself. Whereas community-based activities refer to engagement with others in the teaching community. Instructors were then asked to identify if the activities they indicated, as a whole, were similar to those of a typical week prior to the COVID-19 mandate for remote instruction. A four-point scale (1 = "strongly disagree" to 4 = "strongly agree") was used. For data analysis purposes, the agreement options (strongly agree & agree) were merged to represent 'Typical' activities, and the disagreement options (strongly disagree & disagree) were merged to represent "Atypical' activities.

Data Analysis

Descriptive statistics were used to capture trends in instructors' engagement in various activities to support their teaching over the seven weeks remaining in the Spring 2020 semester. Three analyses were done. It should be noted that weekly response rates to the surveys varied from 77% to 92%. As general trends were of interest in this study, all 39 participants were retained in each analysis.

Table 2. Activities Listed in the Survey [19]

Survey Items	Abbreviations	Self vs. Community
I taught myself something new.	TaughtSelf	Self-directed Activities
I referred to [university based] online resources for teaching.	UNIRes	
I referred to other online [non-university] based resources.	nonUNIRes	
I attended a teaching related workshop.	Workshop	
I read about effective teaching practices.	Read	
I sought help on something specific from a colleague.	GotHelpColl	Community-based Activities
I had a casual conversation about teaching with one or more colleagues.	CasConvo	
I sought help from professional teaching and learning staff.	GotHelpStaff	
I pointed one or more colleagues to resources on teaching.	DirectedColl	
I actively helped one or more colleagues.	HelpedColl	

First, for each participant, the number of times they selected each activity across all seven weeks was determined, regardless of the number of surveys they completed. Then, a percent distribution, by frequency of activity selection, was determined for each activity [20].

Second, the percentage of instructors engaged in at least one activity in the categories of self-directed and community-based during each of the seven weeks was determined. Percentages were computed out of those that participated in a given week's survey. These results were considered with reference to the percent of instructors who indicated that the activities they engaged in were typical.

Third, the percentage of instructors who engaged in each individual activity during each of the seven weeks was determined. This percentage was based on the number of participants responding to a survey in any given week.

Results

Engagement in Activities to Support Teaching

The survey items concerning activity participation were parsed into two categories, *self-directed activities* and *community-based activities* (Table 2). Figure 1 shows the number of weeks (out of seven) each instructor reported engaging in a given activity. The self-directed activities are grouped on the left, followed by the community-based activities. The last bar on the right is concerned with the number of weeks participants indicated engaging in none of the activities listed on the survey.

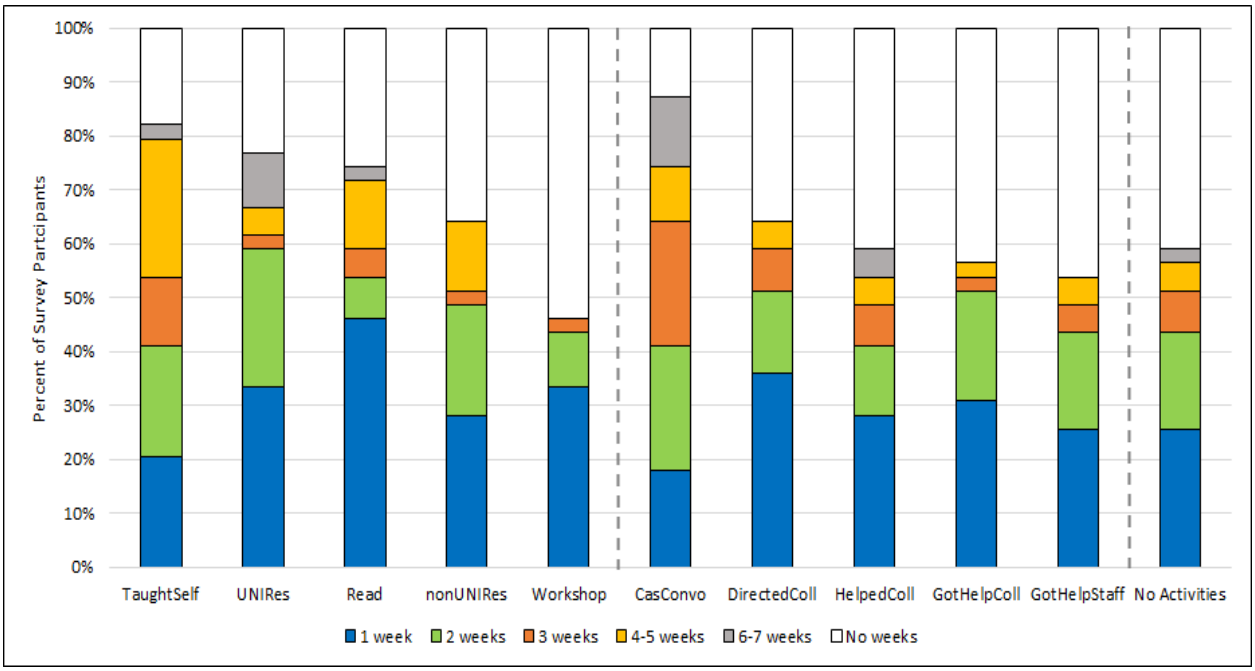

Figure 1. The number of weeks each activity was selected during the seven-week period (*n* =39).

Within self-directed activities, instructors most frequently engaged in teaching themselves something new, with 62% reporting having done this activity in two or more weeks. Instructors reported using university resources in more weeks than non-university resources. Nearly half of all instructors read about effective teaching practices during at least one week but it was less common for instructors to engage in reading over multiple weeks compared to the other self-directed activities (with the exception of workshops). Less than half of the instructors participated in workshops during any given week and when they did, it was most often only during a single week. Instructors' reported referring to university resources to support their teaching in more weeks than non-university resources.

Within community-based activities, instructors spent more weeks engaging in casual conversations with the teaching community compared to other community-based activities. The other community-based activities were equally popular.

Over 50% of instructors had at least one week during the seven-week period in which they did not engage in any of the listed teaching-related activities. Eight percent of the instructors self-reported engaging in none of the teaching-related activities listed in the survey in four or more weeks.

Self-Directed and Community-Based Activities Typicality

Figure 2 shows instructors' weekly engagement in the two categories of activities over the seven-week period. An instructor was considered to be engaged in an activity category in a given week if they had selected at least one activity listed for that category. In general, the percent of instructors engaged in both categories of activities was above 80% in weeks 12 and 13. After week 13, there was a steady decline in participation in these activities with a low of 32% during

the issuing of final grades. The one notable exception is an increase in community-based activities during finals week (67%).

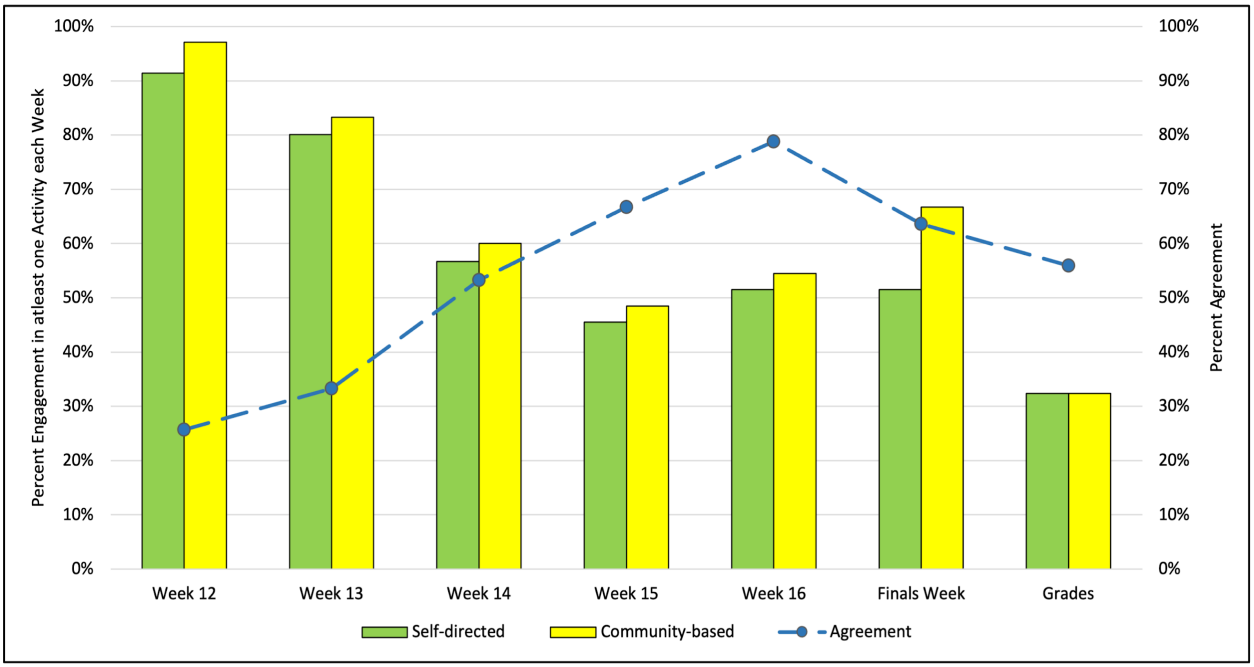

Figure 2. Engagement in self-directed and community-based activities each week and overall agreement of typicality in the two categories of activities (n = 30-36 depending on survey).

Figure 2 also shows the percent of instructors' who agreed that these activities were typical of a non-COVID semester. Note the instructors' agreement that these activities were typical (blue line) applied to all activities they selected in a given week. The majority of the instructors felt their engagement in these activities was atypical in weeks 12 and 13. Starting in week 14, the majority of instructors agreed that their engagement in both categories of activities was typical, though the maximum agreement only reached 79%.

Individual Activity Trends

Figures 3 and 4 show instructors' weekly engagement in each of the self-directed and community-based activities, respectively. Figure 3 shows that instructors' engagement in teaching themselves something new was the most frequently cited self-directed activity, and that teaching themselves something new continued to be the most reported activity through finals week. Instructors' engagement in reviewing university-based resources was high in week 12 (74%) but quickly dropped in week 13 to 39% and continued to drop through to week 15 (9%). Likewise, instructors' engagement in referring to non-university resources and reading about teaching practices trailed off starting in week 13. Forty percent of the instructors attended workshops at the start of the seven-week period. While workshop attendance increased slightly at the end of the seven-week period, there was little participation in workshops in the intervening weeks. In each week, except week 15, instructors reported referring to university resources on teaching more than referring to non-university resources.

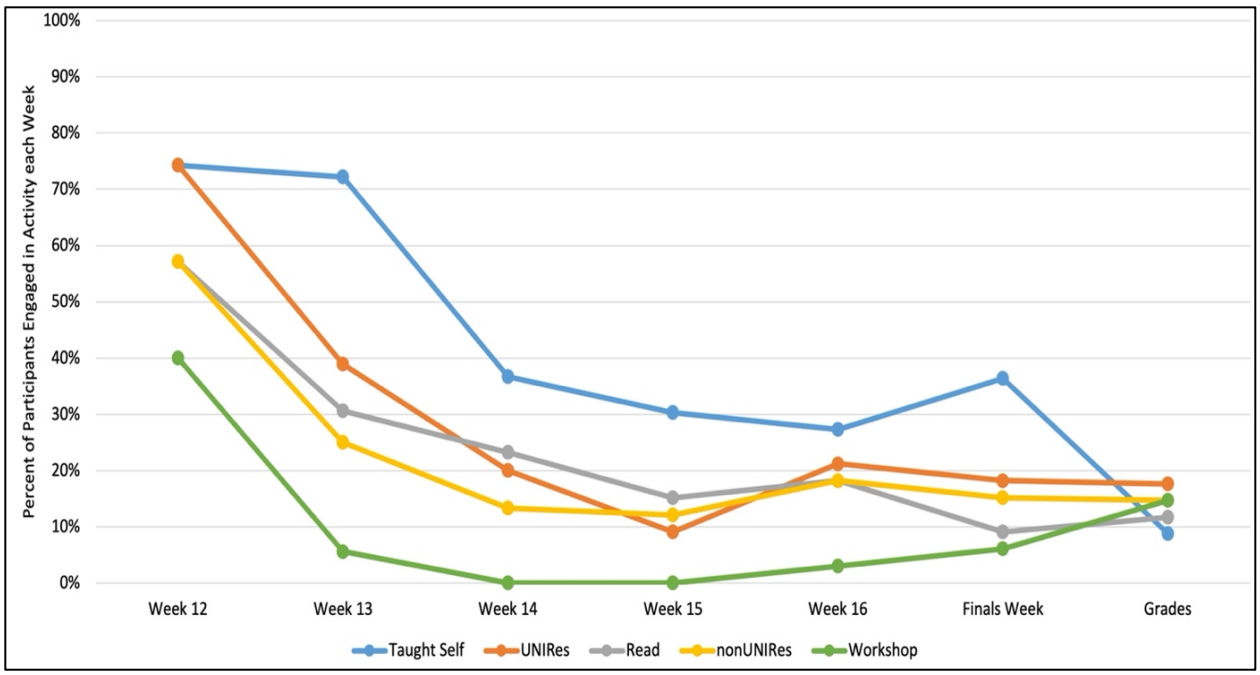

Figure 3. Participants weekly engagement in self-directed activities.

Figure 4 shows instructors' engagement in casual conversation was the most frequently reported community-based activity each week, with the exception of finals week. Each of the other community-based activities followed a similar trend, with the highest reported instructor engagement occurring in week 12 and engagement decreasing in subsequent weeks. Notable exceptions include helping colleagues in week 16 and seeking help from professional teaching and learning staff during finals weeks.

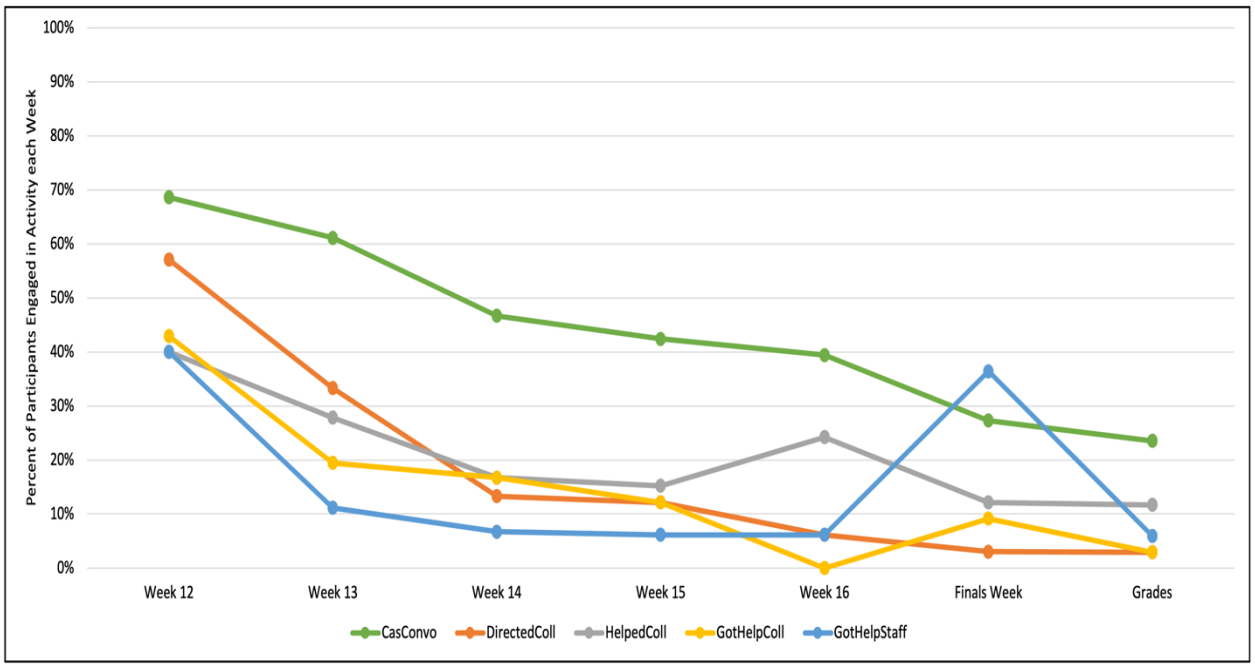

Figure 4. Participants weekly engagement in community-based activities.

Discussion

The results of this study contribute to the ERT knowledge-base by identifying the types of activities that instructors engage in at different points during the early days of a crisis. A number of findings are clear. First, instructors engaged in teaching themselves something new, particularly in the first two weeks of this ERT experience. This early engagement in learning something about teaching likely marks instructors' efforts to use web conferencing to teach their course, recording and posting video content, and sharing course materials through their learning management systems. The finals week peak in learning something new coincided with remote delivery of exams and students' final presentations. As stated in a report from Every Learner Everywhere [21], instructors that lacked prior online teaching experience struggled to adapt their instructional practices to a remote environment. Consequently, this technological shift to ERT required knowledge, skills, and understanding of effective online practices for a successful transition to remote teaching [18, 22]. This finding suggests that instructors facing an ERT circumstance need easy to find and practical resources that enable Instructors to quickly adapt to a change in circumstances and troubleshoot.

Second, participants engaged in casual conversations in more weeks than any other community-based activity. While the percentage of participants engaged in casual conversations was relatively high during the first two weeks, engagement in that activity declined over time. This may have been an effect of university mandate. Starting in week 14, instructors were no longer allowed to use university facilities, significantly reducing opportunities for in-person casual conversations about teaching. Having to rely on remote methods (phone calls, text, email, web-conferencing, etc.) for casual conversations likely made it less probable that those conversations could occur. Despite this limitation, casual conversations with colleagues still remained the dominant community-based activity, perhaps indicating their importance when instructors are faced with an ERT situation. The lack of access to on-campus physical resources, staff, and opportunities for conversations with colleagues may have negatively contributed to instructors' ability to adapt. Social support from the environment is positively associated with adaptability and life satisfaction [12]. Therefore, facilitating opportunities for these informal conversations needs to occur.

Third, it is evident that instructors do not take the same advantage of opportunities offered by teaching and learning staff that they do of teaching themselves or engaging with colleagues. The notable exceptions to this were early attendance at workshops during the initial transition and later during finals week when instructors were faced with delivering completely remote exams for the first time. Seeking help from professional staff may have been more common during these times due to less institutional knowledge available among colleagues. As Every Learner Everywhere [21] reported, many instructors indicated that their institution was the most helpful source of support during the transition to remote teaching, consequently, making it easier for instructors to adjust to unexpected circumstances [7-10] and to ERT. However, support services (e. g., technology support, instructional design staff, teaching and learning center, etc.) varied across institutions, making it difficult for instructors to get assistance. Holliman *et al.,* [17] asserted that employees whose autonomy is supported by their university are able to easily adapt. Thus, during a crisis situation, universities need to have ample support staff available for a

seamless transition and consider how they are supporting instructor autonomy during transition to and implementation of ERT.

Konig and colleagues [22] suggest this rapid transition to remote teaching, at a minimum, requires knowledge and skills. As was seen in these findings, engineering instructors developed their knowledge and skills through a variety of self-directed and community-based activities with the specific activities they engaged in changing over time with the demands of the semester and the crisis context. A better understanding of instructors' choices of activities can be garnered by exploring their success and challenges and perceptions of teaching during ERT.

This study only focused on the behavioral aspect of adaptability. Future research will use other data sources (e.g., other questions in the surveys as well as interview data) to explore the emotional adaptability and teaching cognition of engineering instructors when forced to teach remotely [19]. Understanding these dimensions will provide additional insight into how to support faculty development from an adaptability standpoint.

Conclusion

The initial months of the COVID-19 pandemic significantly impacted engineering education. To understand the forced transition from face-to-face instruction to ERT, this study attempted to highlight engineering instructors' engagement in self-directed and community-based activities pertaining to teaching, as well as their perception of whether their engagement in these activities was typical. The findings of this study can serve to identify the resources or supports instructors take advantage of to adapt their instruction under crisis conditions. Further, this study can serve as grounding for rethinking faculty development in terms of faculty adaptability.

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