Evaluating enablers and barriers for remote teaching during COVID-19 pandemic: Experiences of engineering educators

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CONTEXT

With the unprecedented challenges associated with the COVID-19 pandemic, there are urgent calls for Higher Education Institutions (HEIs) to shift from face-to-face to online delivery of coursework. Emergency Remote Teaching (ERT) has emerged as a targeted intervention enabling a temporary shift to online coursework delivery in times of crisis. While there is a large body of literature on 'online teaching', it is still unclear how to cater for ERT situations with regard to: 1) the transition into ERT mode, 2) ongoing curriculum delivery in ERT mode, and 3) the transition to 'new normal' practices following crises.

PURPOSE OR GOAL

This study focuses on the transition into ERT and ongoing curriculum delivery. The research sought guidance from engineering educators on effectively delivering coursework during times of crisis. Specifically, the researchers built on their research experiences in addressing disaster preparedness and response through 'remote immersive collaboration', to identify enablers and barriers for emergency remote teaching that could guide engineering educators to make right time, right place decisions for effective learning and teaching outcomes during times of crisis.

APPROACH OR METHODOLOGY/METHODS

An exploratory study was carried out to identify barriers and enablers for engineering educators to engage in flexible learning and teaching activities during crises. A series of semi-structured interviews were conducted with engineering educators within one Australian University, focusing on the COVID19 pandemic as a lived experience of teaching in a crisis.

ACTUAL OR ANTICIPATED OUTCOMES

The findings of the semi-structured interviews comprised synthesised insights regarding: 1) Digital literacy of the participants; 2) Barriers for a rapid transition to ERT; and 3) Enablers and opportunities to improve ERT. All participants acknowledged the importance of doing online teaching well during the COVID19 crisis but felt under-prepared and at times ill-equipped to deliver what was expected by management and the students themselves.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

The authors conclude that ERT relies on significant digital enablement, which has happened during COVID19 in an *ad hoc* manner, led by champions in the form of individual staff and local School leadership. The authors highlight the opportunity to use the gathered ERT evidence about perceived enablers and barriers to inform systematic and prioritised actions at the level of School and Program.

KEYWORDS

Emergency remote teaching; barriers; enablers; disruptions

Introduction

With unprecedented learning and teaching challenges during the COVID19 pandemic, in early 2020 Higher Education Institutions (HEIs) shifted *en masse* from face-to-face to online delivery of coursework (Taylor-Guy & Chase, 2020). Online teaching can be described as all types of teaching which occurs though an electronic network including fully online of a combination of face to face and online activities (i.e. blended learning). In the past, online curriculum has typically involved planned creation or renewal in advance of delivery. However, during COVID19, educators were compelled to rapidly transition from face-to-face to remote coursework delivery solutions midway through delivering coursework.

While current coursework relies almost solely on online delivery, it is expected to return to some form of face-to-face delivery as this crisis subsides (Lee, 2020). This 'temporary' elevated online learning and teaching environment has been coined as '*Emergency Remote Teaching'* or 'ERT' (Hodges, Moore, Lockee, Trust, & Bond, 2020). While a large body of literature exists regarding 'online teaching', it is less clear how to cater for such ERT contexts regarding: 1) the transition into ERT mode, 2) ongoing curriculum delivery in ERT mode, and 3) the transition to 'new normal' practices following crises.

This study enquires into the first and second contexts asking, '*What are the barriers and enablers for engineering educators to transition from face-to-face to online coursework delivery during the COVID-19 crisis?'* An exploratory study including literature review and semi-structured interviews with six staff members was carried out within one University in mid-2020, to synthesise barriers and opportunities influencing educators in delivering coursework during the COVID19 pandemic.

Literature Review

With the current COVID19 crisis the importance of online teaching has become more apparent. An online instructors' role goes beyond a traditional lecturer's role and encompasses a broad set of elements including 'professional', 'pedagogical', 'social', 'evaluator', 'administrator', 'technologist', 'advisor' and 'researcher' (Bawane & Spector, 2009).This means that the transition to online teaching may require parallel changes in teaching philosophy, objectives, attitudes and cultural norms (Habermas, 2015).

Previous studies have shown a variety of barriers influencing educators' uptake of online teaching. Hogan and McKnight (2007) argued that exhaustion, depersonalisation and personal achievement related to online teaching would have an emotional influence on the teaching practices. Other barriers include technical constraints related to hardware and software, reliability of technology institutional technology support (Perreault, Waldman, Alexander, & Zhao, 2002), resistance to innovation and online teaching techniques (Singh and Hardaker, 2014), impersonal nature of online courses, heavy workload associated with teaching online (Liu, Kim, Bonk, & Magjuka, 2007) and time limitations (Anderson, 2012). Furthermore the quality of online education, inadequate knowledge on online pedagogy, lack of face-to-face interaction, and lack of training have also been identified as potential barriers for online teaching (Shea, 2007).

A higher proportion of barriers were attributed to the individual level, highlighting the importance of understanding the educator's personal experience and realities of online teaching. To address the barriers influencing the uptake of online teaching a number of enablers including top-down and bottom-up approaches to diffusion, environment of trust and collaboration and supporting infrastructure were identified by Singh and Hardaker (2014).

Research Approach

This paper specifically focusses on barriers and enablers related to emergency remote teaching (ERT) during crisis, namely the COVID19 pandemic. An exploratory approach was adopted to investigate engineering educators' experiences of the rapid transition of coursework delivery from face-to face to online during COVID19 (Cooper, Schindler, & Sun,

2006). A series of semi-structured interviews were carried out with six engineering academics (coded as P1-P6) from civil/ environmental engineering, construction management and aviation disciplines in one University in Australia (3 males, 3 females). Participants were selected based on two criteria: the participant must have experienced the recent online transition of coursework; and have previously done face-to-face teaching. The interview questions were formulated based on the learnings gathered from key literature on online teaching, barriers, and enablers (Rubin & Rubin, 2011). The interviews were conducted through MS Teams software and were digitally recorded. Interviews were undertaken (ensuring anonymity of each participant) to explore engineering educators' experience on emergency remote teaching, in accordance with University Human Research ethics approval. The recordings were then transcribed and thematic analysis conducted to identify patterns and emergent themes (Braun & Clarke, 2006). Interview questions and analysis of results (undertaken by the first author) used language that already exists within the domain of disaster management and disaster response (Desha, Perez-Mora, Hutchinson, & Caldera, 2019; Desha & Caldera, 2019). During data analysis, the first two authors also referred to several previous studies in online engagement to help synthesis the findings (Desha, Perez-Mora, Caldera, Fukui, & Naidoo, 2020).

Thematic Findings and Discussion

The findings of the semi-structured interviews are presented through a summary of digital literacy, and then using the three synthesised themes of: 1) Digital literacy of the participants; 2) Barriers for a rapid transition to ERT; and 3) Enablers and opportunities to improve ERT.

Digital literacy of the participants

All participants understood the University's rationale for rapidly transitioning to online delivery of coursework. This transition created extra pressure that was disruptive (P2, P6). For example, "*When the number of COVID-19 positive cases was rising, the University decided to suspend large classes. We did that immediately… However, at the time, we didn't know the extent of the impact of COVID-19, so we thought we can still run our studios, labs and tutorials. And two weeks later, we discovered that we would not be in a position to offer even smaller classes face to face"* (P6).

Most participants reflected on the differences between online teaching and emergency remote teaching. While online teaching within a normal context was identified as, '*the experience of the teacher and the learner in an online environment'*, the transition to emergency remote teaching was identified as '*the temporary shift of face-to-face learning and teaching activities into an online environment during a crisis period'*.

The lived experiences of the participants ranged from no previous online teaching experience ('digital newcomers') to experienced online teachers ('early adopters'). Several digital newcomers shared their *"at times highly stressful"* (P1) experiences of rapid upskilling in online platforms and the *"at times overwhelming"* (P4) variety of online tools for communication, course delivery and assessments. Overall participants preferred 'Collaborate Ultra' to deliver live lectures and MS Teams for easy and quick communication and interactive tutorials. In addition, online quizzes (Blackboard) and Google Forms were used for low-stake or no-stake assessments to engage students throughout the trimester.

Barriers for a rapid transition to ERT

All participants shared a range of barriers and challenges associated with ERT which were largely experienced at the beginning of the rapid transition from face-to-face to online delivery. These barriers predominantly represented issues related to administrative, practical, social and technical aspects. Table 1 presents a summary of key barriers faced by educators. The barriers are grouped into six categories (i.e.: individual, administrative, financial, practical, social and technical).

While the individual barriers were largely focussed on the increased workload associated with ERT, there was also some emphasis on the changes to the timing of workload. Two participants pointed out that the workload increases due to the rapid transition and upskilling requirements as a key barrier. For example, participant 1 said, "*Possibly the sudden upskilling in the variety of online platforms that are available"*. With the currently available types of technology-enabled platforms licensed through the University (i.e.: Collaborate Ultra, MS Teams, Echo 360) educators were instructed to immediately select and adjust into a new online delivery mode.

Many of the educators struggled to have the same level of passion and energy they would normally have in a physical environment due to limited real-time feedback (e.g. facial expressions) in online delivery. For example, participant 6 claimed that doing a lecture is like conducting a show or a performance, *"I used to think of myself being on a stage where I move around and talk to people and pick up on things. And you know, I use any material around me as part of my teaching to engage students. Now I've lost that, so that has changed me".* Participant 5 reflected on positively using the rush of adrenaline associated with public speaking and bring more energy into face-to-face lectures. However, this was lacking in the ERT process where they felt like speaking to a less interactive computer screen which did not induce the same level of motivation. For example, participant 6 reflected, *"Adrenaline will give you a lot of energy and inspire you a lot to talk, use more examples of real-life examples to illustrate theories. Talking to a screen doesn't give you that kind of inspiration"*.

Table 1: Barriers and key considerations for delivering ERT

Category of barriers	Key considerations
Individual	Additional workload in catering for dual-mode teaching
	Changes to the timing of workload (up-front, pre-course)
	Limited real-time feedback (e.g. facial expressions) in online delivery
Administrative	Inflexible timetabling (e.g. having to schedule self-paced learning)
	Re-writing quizzes and exams (new and re-worded questions) for online integrity
	Responding to institutional reporting requests (e.g. student numbers, actual hours spent)
Financial	Significantly reduced sessional funding support for course-work assistance
	Significantly reduced marking assistance
	Lack of funds for paid subscription to online support tools (e.g. Feedback Fruits)
Practical	Difficulty in creating virtual versions of laboratory practicals
	Increased workload to pre-record practical aspects of the course
	Use of multiple platforms creating confusion for staff and students
Social	Lack of social interaction
	Lack of student engagement
	Inability to judge student engagement
Technical	Unstable internet connections for students and staff
	Limited bandwidth capacity on staff and student machines
	Limited hard drive (storage) capacity on staff and student machines

Within administrative barriers, re-writing quizzes and exams (new and re-worded questions) for online integrity were highlighted as a major barrier (P3, P4, P5). While final exams are generally administered on campus with assigned invigilators, conducting them online was a common issue for most participants. Several participants raised that conducting online exams may lead to academic misconduct or collusion. For example, participant 4 said, *"Honestly my first-time preparing exam online. Preparing it in such a way that students cannot collude, it was very challenging"*. In addition, responding to institutional reporting requests (e.g. student numbers, actual hours spent) were also highlighted as key considerations.

Significantly reduced sessional funding support for course-work assistance and reduced marking assistance created a challenge for many convenors who needed additional support with the ERT. One of the senior academics claimed that budget constraints substantially increased her teaching teams' workload and therefore was the most critical barrier for her. For example, P1 said, *"The first barrier would have to be lack of budget for tutoring to support the course up in its online format".*

Complexities related to social interactions were also highlighted as a barrier for educators. The limited capacity to understand student behaviour and limited student engagement was also raised by P3, P4, P5, and P6. For example, participant 6 said, *"How do I understand the challenges that the students at the other end are facing?".* Participant 6 also illustrated how the body language of students indicates their level of engagement in a face-to-face environment. This participant highlighted the criticality of understanding students' journeys and emphasized the need to be empathetic towards students. Participant 3 added to this by stating how lack of personalised communication had impacted the relationship between the learner and the educator, especially not being able to have conversations about professional growth and employability. Furthermore, participant 4 stated, "*So what I used to do when I was on campus is to share with them something additional to what they have to do in class. For example, some students want to know how to do the professional certification of project management or they want to know about how to be a professional engineer*". This is indeed a significant challenge for the broader higher education sector and will impact the preparedness for the workplace.

Technical barriers including unstable internet connections and limited bandwidth capacity on staff and student machines were also highlighted by P1, P4, P5 as working with digital software was a core component of their course units. Typically, the students would be using this software in a computer lab and would have in-class assistance. However, in a remote environment, educators struggled in assisting and guiding them through the software exercises. Furthermore, laboratory experiments were conducted with the aid of pre-recorded videos. Participant 4 raised concerns related to the lack of tactile learning experiences. For example, "*It was very hard to do online because you know you need to make sure the camera is recording is showing what you want to demonstrate. Whereas in the class you know I would do the physical demonstration, I will pass it on to my students to have a feeling of it and see, for example, how the beam would bend at the top of the reinforcing bars. They didn't have these experiences online"* (P4).

Enablers and opportunities to improve ERT

Overall, the participants in this study emphasized that ERT as a critically needed digital transition for risk mitigation in times of crisis. This section presents key enablers elicited from the lived experiences of the interviewees to better prepare and effectively engage in ERT practices (Table 2). These five enablers include: 1) Pre-emptive course design and delivery; 2) Empathetic communication with students and staff; 3) Pragmatic assessment (timing and content); 4) Adaptive learning infrastructure (face to face and virtual); and, 5) Responsive technical services environment.

Table 2: Enablers and key considerations for delivering ERT

Category of enablers	Key considerations
Pre-emptive course design and delivery	Front-loading design and content (with learning and teaching support)
	Pre-recorded videos (lectures, lab demonstrations, software training)
	Live lectures (with additional sessions with guest lecturers)
Empathetic communication with students and staff	Interactive online sessions (breakout groups, whiteboard, polls)
	Check-in question and answer sessions
	Virtual teaching team check-ins
Pragmatic assessment (timing and content)	Online quizzes that are formative and summative
	Regular reflections
	Virtual laboratories/ workshops/ tutorials
Adaptive learning infrastructure (face to face and virtual)	Familiarity with multiple platforms (e.g. Teams, Collaborate Ultra, Zoom)
	Access to just-in-time training for existing and emergent tools
	Membership of Learning and teaching support virtual sandpits
Responsive technical services environment	Coordinated and flexible technical staff support for coursework delivery
	Technical staff trained in remote laboratory platform technology
	Course software accessible through online access and cloud platform

Building on the trimester 1 experience of the rapid transition to ERT, educators reported pre-emptive course design and delivery through front-loading of information, using pre-recorded

videos, and using a combination of live lectures and online interactive sessions with students as critical enabler. For example, Participant 1 shared, *"To be efficient from the start that requires quite a lot of front-end loading of the curriculum design process".* This included pre-recorded videos of lab demonstrations and software instruction. P1 added*, "they can be setting up a matrix of videos, smart looking tables inside Blackboard with the right links. Even having a better appreciation of the content area in Blackboard so that we're setting up folders there to make it easy for the students*". Participants identified the learning and teaching consultants being readily available to support the academics was a key consideration in assisting them.

Secondly, empathetic communication was a key enabler to offer a sense of belongingness to students. Participant 6 said *"I had some kind of empathy when it comes to understanding how the students might be struggling to link and continue listening to and interacting and engaging with the materials"*. Furthermore, breakout groups, whiteboards, and polls were identified as tools to better engage students. For example, participant 2 said "*I think I do want to bring in polls. Because it gets more interaction from the students".* Academics could also use analytics to check their progress on students' access to course material and send follow-up emails to ensure students are not falling behind. Participant 1 explained that they were "*in the process of just working out how to do them. Checking in statistics for the course Blackboard to see who's looking at what"*.

Thirdly, pragmatic assessments were also highlighted as a way of ensuring student engagement. It was suggested that written reflections and low-stake or no stake quizzes run throughout the trimester as an effective way to engage students in the course content. For example, Participant 6 said, "*Perhaps getting the students to develop a scenario that reflects what they did after each module and becomes the part of the assessment itself. The students have to write their interpretation of certain scenarios that reflect how those three or four lectures collectively. In doing that, you're enhancing the interaction and engagement"*. To ensure student integrity in assessment, creating a large pool of questions, and having a mechanism to provide a shuffled set of questions to each student attempting the exam remotely were suggested. Participant 3 shared, "*So when arranging this, the online quiz was different from last year because I had to transform everything to be multiple choices. I created a lot of questions to form a question bank to make sure that if two students are sitting next to each other, they won't get the same question."* (P3). Participant 4 suggested using calculation-based questions in online exams so students can be better evaluated for applying the equations they have learned in class when selecting the answers in the online multiple-choice question exam.

Adaptive learning infrastructure (face to face and virtual) and responsive technical services environment were also identified as key enablers. One suggestion for coordinated and flexible technical staff support was *"a workstation in a building that you could go to if you're having problems or something like that"* (P2)*.* Another consideration was course software accessible through online access and cloud platform. For example*, "We need to get the University needs to work with the vendor who offers a net platform"* (P1)*.* Lastly, all participants accepted that staff and students are adapting to remote online teaching and there is a great level of flexibility in engaging in learning and teaching activities.

Our findings in relation to ERT are consistent with the barriers for online teaching uncovered through previous literature. In particular, the individual barriers align with findings of Hogan and McKnight (2007) that depersonalisation and personal achievement related to online teaching would have an emotional influence on teaching practices. However, lack of laboratory practicals, additional recordings to demonstrate practical aspects of the course, and software download capacity were key barriers that were specifically experienced by engineering educators and must be addressed by the institutional levels if a remote teaching approach is to be effective. While these barriers were identified through the lived experiences of the interviewed educators, it is critical to identify opportunities and enablers to delivering engaging learning experiences to students during ERT processes.

Based on these findings and those previously discussed, two key propositions that relate to the research question were identified. Firstly, several key enablers can guide engineering educators to effectively engage in emergency online coursework delivery. Secondly, ERT coursework delivery must proactively address a variety of teaching barriers

Conclusion

Augmenting existing literature on using digital technologies for immersive collaboration and online research, this emergency remote teaching research concludes the importance of context in times of crisis. In particular, the sudden and potentially surprising influences of external priorities demands course and program specific responses to still deliver the desired learning outcomes. The authors have synthesised a range of perceived ERT enablers and barriers to support proactive and systematic decision making by lecturers and management. Both digital newcomers and emerging adopters can use this gathered evidence to inform expectations about realistic learning and teaching outcome during crises. This research project provides a useful template to conduct additional studies, towards statistically verifiable findings beyond the authors' insights from this study.

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