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Applying Cynefin framework to explore the experiences of engineering educators undertaking ‘emergency remote teaching’ during the COVID-19 pandemic

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Abstract

Higher Education Institutions (HEIs) around the world are all facing the challenge of delivering coursework online. Following a decade of evolving online education options, in 2020 ‘Emergency Remote Teaching’ (ERT) emerged as an accelerated intervention to enable the rapid implementation of wholly online coursework delivery during the COVID-19 crisis. Amidst subsequent university budget cuts, such online arrangements are also appealing as a lower-cost delivery option. However, there is ongoing uncertainty about how to ensure quality offerings in such online learning environments, to meet national and international program accreditation requirements. Addressing this uncertainty, the authors undertook an exploratory study of engineering educator experiences with online curriculum delivery during the COVID-19 crisis. The Cynefin framework was used to conceptualise a structured narrative for considering the institutional context likely to be present in a given crisis, to then provide a pathway for educators to consider curriculum delivery options where the pedagogical tools must be changed but the underlying desired competency development (i.e., learning outcomes) remain unchanged. Semi-structured interviews with educators were conducted to help appreciate the spectrum of challenges faced in one university. Synthesising the findings, we present a summary of ERT concerns and opportunities to support educators in rapid curriculum renewal during times of crisis. We conclude the significant opportunity to replicate this study’s exploration with a larger sample size, to manage online curriculum renewal going forward.

Keywords: Emergency remote teaching (ERT); Cynefin Framework, Online course delivery, Learning outcomes, Competency development, Engineering graduate outcomes

1. Introduction

In early 2020, responding to the COVID-19 pandemic circumstances, Higher Education Institutions (HEIs) shifted *en masse* from face-to-face to online delivery of coursework (Taylor-Guy & Chase, 2020). This ‘temporary conversion’ to wholly online learning and teaching environment has been coined ‘Emergency Remote Teaching’ or ‘ERT’ (Hodges et al., 2020). This includes all types of learning occurring through a digital internet-based network spanning virtual ‘live’ face-to-face sessions with one or more students, through to pre-recorded, self-paced online activities, and including online delivery of formative and summative assessment.

In Australia and other countries, engineering bachelor’s degree accreditation requirements have long-included the expectation of on-campus components to coursework throughout each program (Usher & Barak, 2018; King, 2008; ASCE, 2019; Hargreaves, 2016). As digital innovations such as augmented and virtual reality have begun to enter educational spaces, there has been increasing dialogue about opportunities and challenges in integrating online delivery, disrupting the assumption that students’ physical ‘on-campus’ use of tools (McAuliffe et al., 2009), software programs, equipment and experimentation are essential to develop certain required competencies (Ryoo & Winkelmann, 2021; Timmis et al, 2016; Wyatt-Smith, Lingard & Heck, 2021; Engineers Australia, 2017). Over the last year, COVID-19 related risk management measures have required the accelerated development and delivery of online ‘virtual-campus’ curriculum, by universities individually, and also by tapping into existing online free or user-pay outsourced curriculum options for students to engage with, which may be from the same country or from somewhere else internationally (García-Peñalvo et al., 2021; McInnes, Aitchison, & Slood, 2020).

As the COVID -19 crisis subsides it is expected that most countries’ higher education systems will return to some proportion of face-to-face program delivery (Lee, 2020). However, there are increasing pressures to consolidate physical teaching spaces and equipment purchasing and maintenance where possible, to reduce COVID-19 related financial stresses being experienced by universities (Lapitan et al., 2021; Jones & Sharma, 2020, Tesar, 2020). Subsequently there is emerging discourse about what proportion of an engineering bachelor’s degree curriculum can remain online as a permanent shift in curriculum delivery (Revilla-Cuesta et al., 2021; Tang et al., 2020). With the goal of supporting educators to provide quality engineering education, we propose it is consequently urgent and timely to enable rigorous and robust evaluation of ERT methods including online delivery. Such evaluation can then provide an evidence-base to

inform which ERT-led curriculum initiatives could be integrated within ‘business as usual’ program delivery, to maintain or enhance the quality of engineering programs going forward.

As a first step in supporting engineering educators evaluate ERT methods, our research project sought to understand the challenges and opportunities in implementing ERT, and potential implications of the ERT experiences for ongoing curriculum delivery after the emergency subsidies. Reflecting on our research experiences in rapid curriculum renewal (Desha and Hargroves, 2010), capacity building for sustainable development (Desha, Rowe, & Hargreaves, 2019; Desha, Caldera & Hales, 2021; Desha and Dawes, 2013) and ‘remote immersive collaboration’ technological innovation (Desha et al., 2020) we asked, *‘How can educators use a sense-making framework to evaluate enablers and barriers to transitioning to online teaching?’*

In this paper we document our subsequent exploratory study, which included literature review and semi-structured interviews with six staff members in one University in mid-2020. We begin by presenting our rationale for engaging with a sense-making framework to conceptualise context and evaluate the extent to which ERT can meet learning outcome goals. Synthesising the findings of the study using the framework, we then present a summary of ERT concerns and opportunities for educators to consider when engaging in curriculum renewal. We recommend these findings also be used to inform decision-making about ERT-led changes – such as online delivery – to ‘business as usual’ curriculum offerings, to ensure sustained or enhanced quality outcomes.

2. Context for the study

In the following section we introduce the Cynefin framework as a lens to evaluate learning environments, and subsequently to provide decision-support for curriculum renewal that is conducive to students developing desired competencies. We then situate the study in the globally experienced ERT method of online curriculum delivery.

2.1 Cynefin Framework

Situated within the narratives of Complexity Theory and Cognition Theory, the Cynefin framework (Snowden, 2000; Snowden and Boone, 2007) was originally developed as a sense-making approach to assist leaders evaluate their challenges and make decisions in any given problem-solving situation or ‘context’. The underpinning assumption is that it is easier for decision makers to develop actions to match their lived reality, when they clearly understand

the characteristics of the reality – the systems – that they are operating within (Snowden, 2019). The framework has since been established as a practice-based sense-making approach to problem-solving within the education sector (Mason, 2009) and more broadly in fields such as international development, public policy, safety and energy, and health promotion practice (Van Beurden et al., 2013). Considering the 2020 rapid onset of the COVID-19 pandemic, the Cynefin framework provides a systematic lens through which we can evaluate educator experiences over that year, in particular the global phenomenon of a rapid transition to online teaching.

Snowden (2000; 2017) proposes that knowledge occurs in five related domains that relate to the extent of complexity and chaos, and the relationship of complexity and chaos to best practice, order and expertise. The five domains are ‘Clear’, ‘Complicated’, ‘Complex’, ‘Chaotic’ and ‘Aporetic’ as illustrated in Figure 1. The first step in using the Cynefin framework is to contextualise a situation in relation to these five domains. Two key features affect which domain might be selected, namely: 1) the availability of information (data), and 2) the effectiveness of constraints governing choices of action (for example standards, rules, predictable application of formulae) (Snowden and Boon, 2007).



Figure 1. Cynefin Framework (Cognitive Edge, 2020)

The right-hand-side of the framework represents knowledge or skills that are generally ‘ordered / orderly’, including problem-solving for known situations with significant empirical evidence guiding ‘the right answer’, aided by effective constraints such as standards or laws that are characteristic of the ‘clear’ domain, or available expertise in the ‘complicated’ domain. The Clear domain is associated with fixed constraints, meaning that there are rules in place and the advice in such a situation is to ‘sense – categorize – respond’. The Complicated domain is associated with governing constraints, meaning that the relationship between cause and effect calls for analysis or expertise and there are a range of correct answers, requiring an approach of ‘sense – analyze – respond’.

The left-hand-side of the framework represents knowledge or skills that are generally ‘unordered’, because the constraints are less visible, less developed, or effective. Considering an educational setting, this would include considering open ended questions in the ‘Complex’ domain, and considering formulae with variables that involve subjective judgement, and problem-solving for novel situations such as unprecedented natural disasters in the ‘Chaos’ domain. Furthermore, in the Complex domain, the cause and effect can only be deduced in retrospect, and there are no right answers; it requires experimental approaches and is governed by emergent constraints. In the Chaotic domain, cause and effect are unclear and is associated with the novel constraints.

For our study, the Cynefin Framework provides a structured narrative for systematically working through a sense-making check-in with each desired learning outcome for a course, to then confidently choose appropriate online tools and approaches to achieve them in a wholly online teaching environment. For example, locating ‘XYZ learning outcome’ in the ‘Complicated’ domain regarding the type of information and constraints that students need to work through, would likely lend itself to needing different online approaches, compared with if it is located in the ‘Clear’ domain. In the discussion section, we use this sense-making conceptualisation to reflect on how educators’ *ad hoc* experiences in rapidly modifying curriculum delivery could be improved to robustly consider the development of desired competencies and the best-fit curriculum solution in the ERT circumstances.

2.2 Progress in online curriculum delivery

It has long been recognised that an online educator’s role goes beyond an in-person role, encompassing 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). It is important that the educators' consider the learners' diversity of backgrounds and varying levels of motivation and digital literacy (Veletsianos, 2020) to offer active, participatory, and inclusive learning experiences for students that are at least equally effective as in-person learning environments (Laurillard, 2005).

In the decade prior to COVID-19, a number of key studies pointed to barriers influencing educators' use of online teaching options, as summarised in Table 1. We have categorised the barriers into three groups: social, institutional and technical barriers.

Table 1: Barriers for transition from face-to face to online teaching synthesising key literature (Berge, 1998; Liu et al., 2007; Perreault et al., 2002; Shea, 2007)

Social barriers	Institutional barriers	Technical barriers
Educator fear of workload with unfamiliar / unknown pedagogical practices	Lack of support staff to respond to issues arising	Educator and student difficulties related to accessing hardware and software
Impersonal constraints associated with online norms	Lack of training in teaching online	Reliability of technologies for online delivery (learning and assessment)
Absence of face-to face interactions	Accreditation requirements for on-campus participation	Availability of technologies to replicate laboratory / workshop / field trip experience
Student reluctance to enrol in courses using online delivery		

To overcome such barriers, Singh and Hardaker (2014) recommended a combination of top-down and bottom-up approaches to building an environment of trust and collaboration, and the pursuit of equivalent or improved learning outcomes as an incentive for educators considering the transition. Within this process, maintaining the level of teaching efficacy is imperative to ensure that educators are confident in their ability to facilitate the development of students' knowledge, abilities and values. Self-efficacy can be influenced by teacher anxiety (Presno, 1998), calling for a positive attitude towards online teaching (Veletsianos, 2020).

Three types of presence (i.e.: social cognitive and facilitatory) have been highlighted as significant elements for improved student engagement and online presence (Rapanta et al., 2020). Other techniques that have been identified as key strategies to enhance student learning include maintaining slow voice, sharing resources before the class, allowing student feedback, offering flexible learning and teaching policies, and recording online lectures (Mahmood, 2021).

Creating an effective online learning environment can be challenging, demanding purposeful design of learning activities for better student engagement. This requires a certain level of pedagogical content knowledge (PCK) to create a distinctive learning environment with digital technologies. However, as technology has evolved and more user-cases have emerged – particularly in 2020 – there have also been concerns increasingly raised around the effectiveness and efficacy of the online delivery of course content especially in terms of monitoring performance in skill-related competencies (Alrefaie, Hassanien, & Al-Hayani, 2020). Reflecting on current practices and forming targeted teaching strategies is therefore critical to pave the way for an effective transformation to have learner actively engaged and self-regulated (Veletsianos, 2020; Wang & Torrisi-Steele, 2015). An electronic portfolio (e-portfolio) with appropriate skill-achievement indicators can also be helpful to ensure an evidence-based and purposeful evaluation of the online learning experience (Alrefaie et al., 2020).

3. Research approach

The study used an exploratory approach to investigate engineering educators’ experiences of the rapid transition of coursework delivery from face-to face to online during the first year of the COVID-19 pandemic (Cooper, Schindler, & Sun, 2006), as shown in Figure 2.

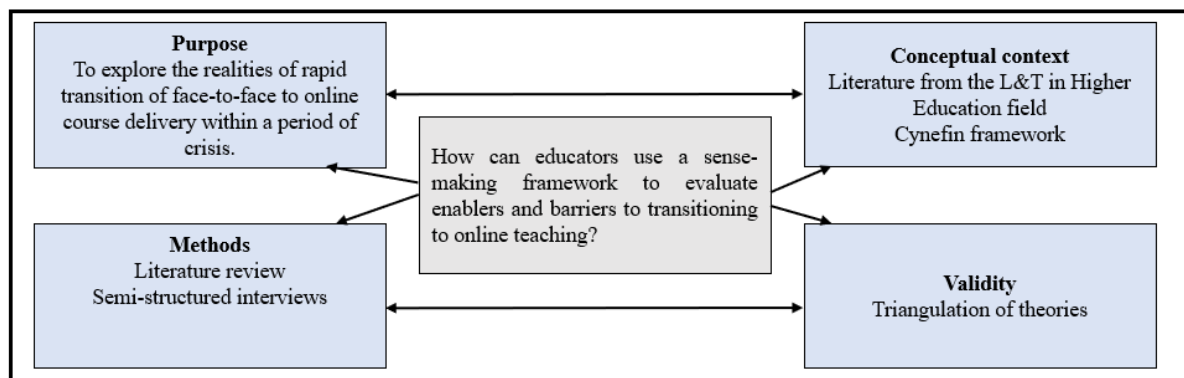


Figure 2: Research design interactive model (Adapted from Maxwell (2012))

This qualitative inquiry allowed for deeper exploration and discovery, regarding whether there was evidence to support the problem, rather than measuring the size of the problem (Mertens, 2005, Male and MacNish, 2015). Interviews facilitate deep exploration of topics raised by the interviewees rather than topics anticipated by the researchers. For our study, a series of semi-structured interviews was carried out with six academics teaching into courses in the engineering program. The interview guide, consent form and information sheet used in the study are attached (Appendices 1-3), compliant with the obtained ethics approval (GU Ethics No: 2020/472). The profiles of the participants from one University in Australia (3 males, 3

females), are summarised in Table 2. Participants were selected based on two criteria: the participant must have experienced the recent online transition of coursework; and the participant must have previously done face-to-face teaching.

Table 2: A summary of the interview participants with their code names

Interviewee code	Position	Background Discipline	Interview duration
P1	Associate Professor	Environmental and Civil Engineering	40 min
P2	Professor	Aviation	30 min
P3	Senior Lecturer	Construction Management	30 min
P4	Lecturer	Environmental and Civil Engineering	30 min
P5	Lecturer	Construction Management	40 min
P6	Professor	Construction Management	30 min

The interview questions (Appendix 1) 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 COVID-19, disaster management and disaster response (Desha, Perez-Mora, Hutchinson, & Caldera, 2019). During data analysis, the first two authors also referred to previous studies using the Cynefin framework to help synthesise the findings (Desha et., 2020; Desha, Caldera and Hutchinson, 2021).

4. Thematic Findings

Overall, the participants in this study emphasized ERT as a critically needed digital transition for business continuity during the COVID-19 crisis. However, there were a range of thoughts about the quality of this experience and the impacts of the experience on the quality of the students' competency development in their undergraduate programs. The findings of the semi-structured interviews are synthesised in the following subsections using four themes that emerged from the transcript analyses: 1) Educator digital literacy; 2) Influence of ERT on educators' professional identities; 3) Barriers to rapidly transitioning to ERT; 4) Enablers and opportunities in transitioning to ERT. For barriers and enablers, we also mapped the findings to the Cynefin Framework domains, understanding that depending on which domain the barrier

or enabler resided in, the educator might be guided differently regarding relevant problem-solving actions.

4.1 Digital literacy of the educators

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. 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 ERT. 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.

4.2 Influence of ERT on educators' professional identities

All participants could reflect on their experiences to identify several key scholarly challenges and apply their new appreciation to creating new 'ERT pedagogy' for learning. It was interesting to observe how educators adopted strategies to achieve an online alternative for their course/s. All participants acknowledged that the ERT process has been influential in broadening their role as an educator. Several participants shared their experience of how their professional identity was impacted. For example, according to one participant, *"Primarily, I've been moving into management roles and mentoring younger staff to do the front face teaching with the*

students. I have been involved in provocation, content development, strategic curriculum design at the back end. I think this experience has markedly changed my workload, I suspect that will be the case for the next at least 18 months or so” (P1).

Another participant added to this by stating it has been a gradual change and pointed out how they were prompted to think of the ERT as a future opportunity to conduct international lectures, “I think it has but for me, it's been more gradual than others. Whether in the future we could have people internationally delivering lectures for us. It has made me think a bit more widely and try to push more on online programs” (P2). Conversely, another participant stated that their professional identity had not changed with the experience, “No, I wouldn't say it has changed my identity. What it has changed in me is I guess I have learned to rely less and less on my usual and interpretive way of how I do things” (P6).

4.3 Barriers to rapidly transitioning to ERT

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. Table 3 presents seven key categories of barriers faced by educators, in attempting to rapidly transition from business as usual to ERT, along with a classification of their considerations – or ‘factors’ – within one of the Cynefin Framework domains (column 3). The barriers are discussed in the following paragraphs.

Table 3: Barriers to rapid implementation of ERT (alphabetical by barrier)

Category of barriers	Key considerations (Factors)	Cynefin domain of the challenge
Administrative	Inflexible timetabling (e.g. having to schedule self-paced learning)	Complicated – unfamiliarity
	Re-writing quizzes and exams (new and re-worded questions) for online integrity	Complicated – range of options
	Responding to institutional reporting requests (e.g. student numbers, actual hours spent)	Clear – known information
Financial	Significantly reduced sessional funding support for course-work assistance	Clear – known information
	Significantly reduced marking assistance	Clear – known information
	Lack of funds for paid subscription to online support tools (e.g. Feedback Fruits)	Clear – known information
Knowledge	Lack of staff knowledge of online pedagogy	Complicated – unfamiliarity
	Lack of student experience in online learning	Complicated – unfamiliarity
	Limited online learning pedagogy for some knowledge and skill sets	Complicated – applying existing expertise to implement
Personal	Additional workload in catering for dual-mode teaching	Complicated – unfamiliarity
	Changes to the timing of workload (up-front, pre-course)	Complicated – range of right answers
	Limited real-time feedback (e.g. facial expressions) in online delivery	Complex - cause and effect can only be deduced
Practical	Difficulty in creating virtual versions of laboratory practicals	Complicated – range of ‘safe to fail’

	Increased workload to pre-record practical aspects of the course	Complicated – staff, tutors, team
	Use of multiple platforms creating confusion for staff and students	Complex – no certainty of effectiveness until after it is used.
Social	Lack of social interaction	Complex – limited student ‘knowing’
	Lack of student engagement	Complex – limited student ‘knowing’
	Inability to judge student engagement	Complex – limited student ‘knowing’
Technical	Unstable internet connections for students and staff	Complicated – unique per staff/student
	Limited bandwidth capacity on staff and student machines	Complicated – unique per staff/student
	Limited hard drive (storage) capacity on staff and student machines	Complicated – unique per staff/student

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 it was my first-time preparing an exam online. Preparing it in such a way that students cannot collude was very challenging”*. In addition, responding to institutional reporting requests (e.g. student numbers, actual hours spent) were also highlighted as key considerations.

Regarding financial barriers, 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”*.

Regarding personal barriers, while they 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 highlighted the need for, *“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. The interviewed 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" (P6). 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"* (P6). Furthermore, the digital newcomers had limited knowledge of online pedagogy which added an extra layer of difficulty.

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).

4.4 Enablers and opportunities in transitioning to ERT

Participants reflected on what helped them to prepare for and effectively engage in ERT practices. As summarised in Table 4, five categories of enablers emerged from the analysis, including 15 considerations that contributed to improving the quality of the experience – for the educator and for the students. As for the barriers, we subsequently mapped these enabling considerations – or ‘factors’ – within one of the Cynefin Framework domains (column 3) to demonstrate the array of contexts for problem-solving. The enablers are discussed in the following paragraphs.

Table 4: Enablers for delivering ERT and considerations for improving the experience

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

Building on the Trimester 1 (2020) experience of the rapid transition to ERT, educators reported critical enablers as: Responsive course design and delivery. They identified with several key quality considerations including front-loading of information, using pre-recorded videos, and using a combination of live lectures and online interactive sessions with students. 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 identified as 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 agility and flexibility in engaging in learning and teaching activities. The sense-making conceptualisation is discussed in relation to how educators’ experiences in rapidly modifying curriculum delivery could be improved to robustly consider the development of desired competencies through attainment of coursework learning outcomes in section 5.

5. Discussion: Applying Cynefin to the findings

We now discuss the study findings using the Cynefin Framework, interpreting the educators’ experiences through drawing on the framework’s contextualisation process, and in particular the mapping of domains to the barriers (Table 3) and enablers (Table 4).

5.1 Encouraging confidence in beginning with ‘disorder’

Reflecting on the first theme of the findings ‘Educator digital literacy’, the study participants’ initial worries about the ‘newness’ of online learning as a tool can be seen as symptomatic of standing in the central space of ‘disorder’ (Aporetic/ Confused). While the participants reflected on the importance of dealing with the transition to online teaching, there was an absence of any mention of the necessity of having an initial period of disorder in the process. We propose that the acknowledging this experience as the first step in a good-practice process would be reassuring for educators embarking on ERT curriculum renewal.

The interview data indicates that some of the study participants depending on their academic roles managed the dynamic of moving from disorder to the domains of ‘Complex’ and/or ‘Complicated’ as they chose different online tools to substitute for live laboratories, workshops or field trips. It was also evident that the participants quickly experienced failure in attempting to achieve course learning outcomes using methods appropriate for the ‘Clear’ domain – for example giving students online readings to learn about complicated mechanics principles.

5.2 Enabling multiple approaches through returning to ‘disorder’

The ERT online transition stirred up a sense of disorientation for some of the participants (especially the digital newcomers), who were unable to /refused to engage with curriculum renewal after an initial attempt, instead demanding a return to face-to-face teaching. In addition to beginning with disorder, the central disorder ‘Apoletic/Confused’ domain acts as a point that is useful to return to periodically. It may be that multiple attempts are needed before arriving at the successful pedagogy solution. Furthermore, for a given learning outcome, one or more of the quadrant domains may be present and a variety of online pedagogies may be chosen to create the best learning environment. We propose that this guided agility in considering ‘what next’ would help educators address some of the challenges raised in the third theme of ‘barriers to transitioning to ERT’.

Identifying the appropriate domain for coursework then facilitates systematic consideration of teaching approach options. For example, in situating a particular learning outcome such as *‘Ability to apply the formula to solve real world problems’* within the ‘Complicated’ domain, the role of ‘experts’ can confidently be integrated within the curriculum as the knowledge is ordered and inherently known. Alternatively, if it is identified as ‘Complex’, the educator may engage students in ‘discovering’ the knowledge using for example, safe-to-fail experiments that have multiple variations on possible results, with students required to conduct multiple iterations and explore the variability in answers.

Considering this contextualisation process with the overlay of the ERT ‘online’ challenge faced by educators in this study, the renewal pathway would then be immediately actionable – for example in the ‘Complicated’ domain, an educator could focus on preparing recorded worked calculations with examples of experts’ solutions. In the ‘Complex’ domain the educator could focus on creating a virtual experimentation laboratory with recorded commentary by professionals on the need for subjective judgement.

5.3 Guiding student appreciation of sense-making through the Cynefin quadrants

The lived experiences of ERT during COVID-19 crisis were unique to each interviewee, however, most of them appreciated that their educator role now encompassed a new pedagogy in online curriculum delivery. At the commencement of the pandemic, participants were faced with confusion and disorder in a novel situation of delivering the same course learning outcomes, but wholly online; a pedagogy problem. At the same time, educators were standing

in the disorder of the institution called the University, involving a milieu of logistical, cultural and financial problems.

Facing such a situation, the Cynefin Framework helps to differentiate between the confusion of the social and institutional situation, and the pedagogy confusion within the courses being transitioned to an online delivery. Figure 3 presents the seven barrier categories and five enablers as distinguished in the findings, sorted by pedagogic and organisational relevance.

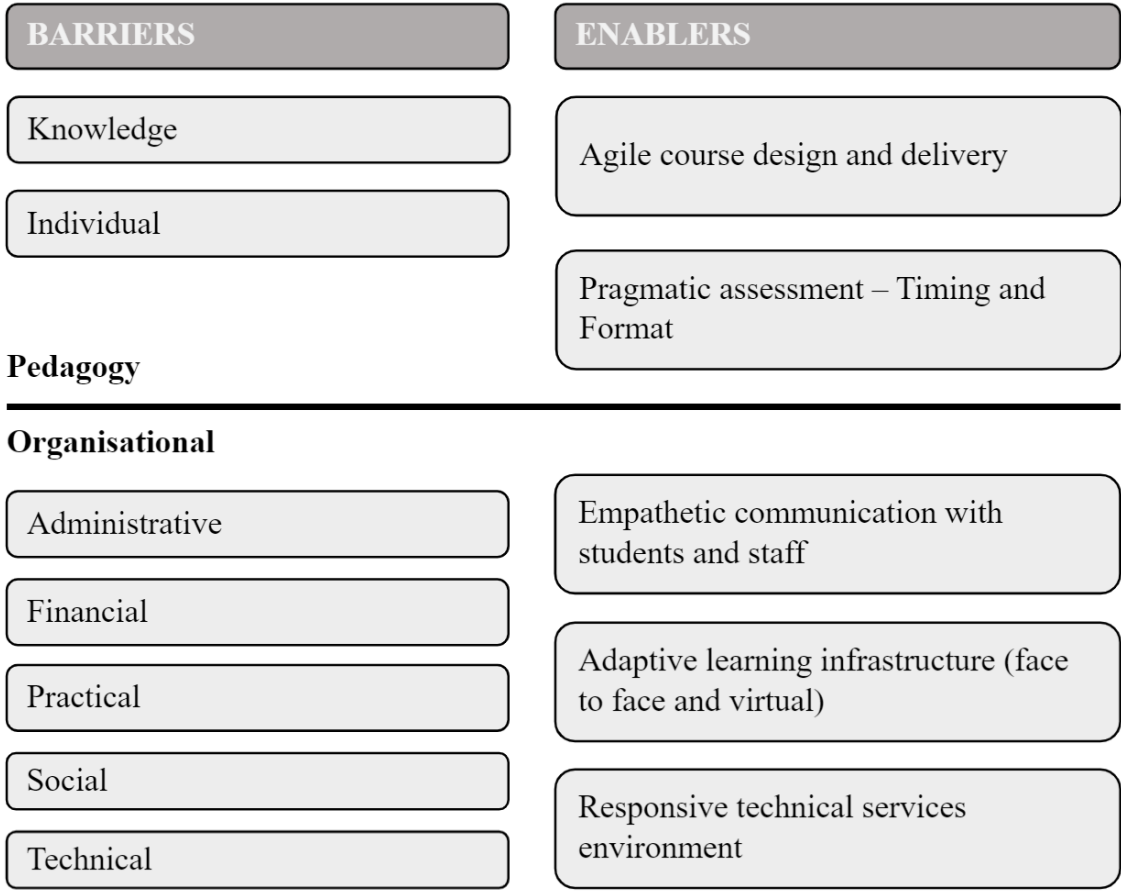


Figure 3. Sense-making of ERT barriers and enablers according to pedagogy and organisational relevance

Distinguishing the barriers and enablers in this way facilitates some of the ERT challenges to be addressed at a School or higher level within the University, to support educator needs that are in addition to the scholarly-related pedagogical challenges.

The confidence challenges expressed by participants (i.e. the second ‘professional identities’ theme in the findings), highlights the impact of collapsing scholarly challenges in applying new

pedagogy to learning, and institutional challenges in enabling educators to perform their work. Even amongst the small participant cohort documented in this study, the variety of personal interpretations about self-efficacy and professionalism can be seen. The Cynefin Framework permits an iterative process of self-reflection during the curriculum renewal process about the context of the situation and the types of pedagogical options available. We propose that such increased guidance is of benefit in both managing time and self-doubt during and after the experience, and enabling the institutional support needs to be separately dealt with.

Considering the institutional barriers for online teaching, our findings align with those discussed by other researchers. 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.

6. Conclusion

This study sought to understand the world of an engineering educator grappling with curriculum delivery during the first year of the COVID-19 pandemic, finding a mixture of challenging institutional and pedagogical contexts that required different approaches to problem-solving to ensure sustained or enhanced quality of the students' online educational experience. The educators' accounts of their experiences of the sudden shift to largely online delivery methods suggests decision-making in the absence of initially appreciating context and the implications of certain choices. This presents a risk within ERT, to maintaining the quality of graduate competency development across critical knowledge and skill areas.

The Cynefin Framework provided a useful lens to reflect on educator decision-making experiences during ERT and highlighted how the educator and learner experience could be improved by educators taking time upfront in a crisis to distinguish different types of barriers and enablers – in this case regarding online delivery. Reviewing educator experiences, we could observe a range of curriculum renewal barriers and enablers ranging from straightforward ('Clear'), through to 'Complicated', 'Complex', 'Chaotic', and in disorder ('Aporetic'). We propose that framing the decision-making contexts in this way through the Cynefin framework, would enable educators with an up-front systematic appraisal of options and potential

implications. In taking time initially to understand the context of the barrier or enabler, educators can then more confidently take advantage of pedagogy support to address the preservation of course learning outcomes, and institutional assistance to enable the logistics of the ERT delivery requirements.

We propose that the Cynefin Framework mapping method could also be immediately useful going forward in the COVID-19 pandemic, as ERT transitions to a new ‘business as usual’ form of curriculum delivery. For example, educators could undertake a mapping exercise of the barriers and enablers for themselves using the Cynefin Framework, then plan ‘next steps’ accordingly for adjusting the student and educator experience of online program delivery.

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Appendix 1: Semi-Structured Interview Route

Introduction to the Study

Could you please introduce yourself and your role in the School of Engineering and Built Environment?

What is your understanding of 'online teaching'?

1. Can you please explain your overall experience of transitioning from face-to-face to online teaching in T1/T2?
2. What was your experience in using technology enabled platforms during this transition?
3. What is your experience of online communication tools for coursework learning?
4. What is your experience of using online assessment methods?
5. How do you think you could improve the online teaching experience?
6. What would you do differently?
7. How do you think you might use what you've learned?
8. In your opinion, do you think this experience has changed your identity as an educator?

Appendix 2: Information sheet

Evaluating educators' experiences during the transformation of coursework delivery from face-to-face to online mode during COVID19 crisis

GU ref no: 2020/472

Research team details

Why is the research being conducted?

Griffith University has been making a number of changes to the way we teach, to help students continue studying during the Coronavirus (Covid-19) pandemic. This has included transitioning to online teaching and meetings with students during the trimester, doing online groupwork and conducting different types of assessment. This research aims to understand the lived experience of academics during the transition from face-to-face to online and explore opportunities for improving ways of teaching and learning, to further mitigate disruptions caused by COVID-19.

What you will be asked to do

You will be invited to take part in an interview lasting up to 30-40 minutes, conducted via Microsoft Teams. The purpose of these questions is to give you an opportunity to share your knowledge and experience transition to online teaching.

The basis by which participants will be selected or screened

You have been invited to participate in this research as you are an academic in the School of Engineering and Built Environment.

The expected benefits of the research

This research will have several benefits for staff and students. The results will provide an in-depth understanding that can be utilised to promote support of academics in relation to their online teaching experience, during the current pandemic and any potential future crises.

Risks to you

We will record your interview on Microsoft Teams. All recordings will be erased after transcription. All information you provide will be de-identified and your identity will be protected.

While this research is regarded as low risk, it is possible that you may find it distressing to answer questions about your teaching during the COVID pandemic. If you find that you are feeling this way, please seek help from the employee counselling service Benestar 1300 360 364 - <https://www.griffith.edu.au/health-safety-wellbeing/staff-counselling>

Your confidentiality

All information you provide will be de-identified and your identity will be protected. The research data (interview transcripts, documents and analysis) will be retained in a password protected electronic file at Griffith University for research purposes for a period of five years before being destroyed.

Your participation is voluntary

Your participation in the research is voluntary, and you are free to withdraw from the study at any time up until the data has been analysed. Your decision whether or not to participate will have no impact on your relationship with the researchers or Griffith University.

Questions / further information

If you have questions or need further information please contact Dr Savindi Caldera (s.caldera@griffith.edu.au) via email.

The ethical conduct of this research

Griffith University conducts research in accordance with the *National Statement on Ethical Conduct in Human Research*. If potential participants have any concerns or complaints about the ethical conduct of the research project they should contact the Manager, Research Ethics on 3735 4375 or research-ethics@griffith.edu.au.

Feedback to you

The research results will be documented in the form of a technical report. Participants can request for a summary of the research findings via email s.caldera@griffith.edu.au

Privacy Statement

The conduct of this research involves the collection, access and/or use of your identified personal information. The information collected is confidential and will not be disclosed to third parties without your consent, except to meet government, legal or other regulatory authority requirements. A de-identified copy of this data may be used for other research purposes. The research data will be retained for a minimum of five years from the completion of the research project. However, your anonymity will at all times be safeguarded. For further information consult the University's Privacy Plan at <http://www.griffith.edu.au/about-griffith/plans-publications/griffith-university-privacy-plan> or telephone (07) 3735 4375

Appendix 3: Consent form

Evaluating students' and educators' experiences during the transformation of coursework delivery from face-to-face to online mode during COVID19 crisis CONSENT FORM

GU ref no: 2020/472

Research team details

By verbally giving my consent in the interview, I confirm that I have read and understood the information sheet and in particular:

- I understand that my involvement in this research will include an interview of approximately 30-40 minutes in duration, conducted via Microsoft Teams;
- I understand that the interview will be recorded I have had any questions answered to my satisfaction;
- I understand the risks involved;
- I understand that there will be no direct benefit to me from my participation in this research;
- I understand that my participation in this research is voluntary;
- I understand that if I have any additional questions I can contact the research team;
- I understand that my name and other personal information that could identify me will be removed or de-identified in publications or presentations resulting from this research;
- I understand that I can contact the Manager, Research Ethics, at Griffith University Human Research Ethics Committee on 3735 4375 (or research-ethics@griffith.edu.au) if I have any concerns about the ethical conduct of the project; and
- I agree to participate in the project.

Respondent	I am consenting to participating in this research