A Disorienting Dilemma: Teaching and Learning in Technology Education During a Time of Crisis

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Abstract

The way individuals interpret and reinterpret their experience is central to meaning-making and, ultimately, to teaching learning. Grounded in Mezirow's Transformative Learning Theory, this research explores whether pandemic-related emergency remote teaching manifested in a disorienting dilemma for technology educators. Educators negotiated curricular outcomes between physical aspects of making and doing and design and creative problem solving resulting in a pandemic transformed pedagogy. Thematic analysis revealed that making and doing was severely challenged due to decreased communication, student motivation and engagement. However, most concerning to educators was the heightened disparity in equity and access in their most vulnerable and at-risk students.

1. Introduction

Central to meaning-making, and ultimately to learning, is the way individuals interpret and reinterpret their experience especially during times of crisis. Transformative learning (Mezirow, 1991, 2000, 2009) is a dominant theory in adult learning that has considerable support in the empirical literature (Christie et al., 2015; Taylor, 2007, 2008; Taylor & Snyder, 2012). According to Mezirow (1991), this theory explains "how adult learners make sense or meaning of their experiences, how social structures influence the way they construe their experience, and how the dynamics involved in modifying meanings change when learners find them to be dysfunctional" (Christie et al., 2015, p. 10). Transformative learning results in irreversible changes in how an individual experience, conceptualizes and interacts with the world (Hoggan, 2016). Every individual has a particular view of the world that may or may not be well articulated. It is usually based on a set of paradigms that derive from their upbringing, life experience, culture, or education (Christie et al., 2015; Tabak & Weinstock, 2005). Individuals often have difficulty changing because their worldviews become unconscious frames of reference or constructed 'habits of mind,' something that has been clearly illustrated throughout the COVID-19 pandemic (Braund, 2021). Thus, for perspective transformation to occur, reflection needs to be 'triggered' through a 'disorienting dilemma' (Mezirow, 1991, 2000, 2009).

Disorienting dilemmas often challenge the validity of one's values and the assumptions that underpin them. However, designing a 'disorienting dilemma' that prompts a change in attitudes, beliefs and values is not explicitly presented within the theory and is a subject of ongoing research (Christie et al., 2015; Mälkki, 2012). A disorienting dilemma originating from a life crisis can also trigger a change in perspective (Mälkki, 2012). In essence, a life crisis – such as the COVID-19 pandemic – places individuals in an involuntary chaotic situation that forces a change in the ontology where participants experience a transformation in their being in the world and their forms of relatedness (Lange, 2004). During conditions of fear and trauma, little is known about the impact this chaotic way of being has on learners and educators in particular (John, 2016). This article adds to the evidence in this area by reporting on and exploring the 'disorienting dilemma' of the early months of the pandemic – a time of extraordinary global fear and trauma – and the impact this had on secondary technology education teachers during their transition to emergency remote teaching (Hodges et al., 2020).

1.1 The Pandemic Transformed Pedagogy Project

When the WHO Director-General declared SARS-CoV-19, commonly known as COVID-19, a pandemic (WHO, 2020), K-12 school systems worldwide responded with an almost immediate suspension of in-class instruction. In British Columbia, Canada, the Minister of Education directed all schools to immediately suspend in-class instruction (Fleming, 2020), forcing over 500,000 students and 44,000 teachers to shift to emergency remote teaching (ERT; Hyslop, 2020a; Hyslop, 2020b). ERT involves a “temporary shift of instructional delivery to an alternate delivery format due to crisis circumstances” (Hodges et al., 2020). Teaching in online, blended or hybrid learning modalities requires a significant reimagining and re-design of the pedagogy educators use (Jonassen, 2006; Kanuka, 2006). As a result, the shift to ERT necessarily impacts the curricula and content educators teach and requires a change in actions, judgements, and selection of teaching strategies (Jonassen & Land, 2014), leaving many practicing classroom teachers unprepared.

The Pandemic Transformed Pedagogy Project (PTP) began by capturing the needs of technology education (TE) teachers in British Columbia, Canada, during the pandemic. This project’s overall aim is to find ways to empower technology educators with evidence-based learning designs that they can use with their students that are both flexible in their delivery modality yet meet prescribed learning outcomes (Anonymous, 2020a; 2020b). To understand why the pandemic declaration and the switch to ERT was a particularly ‘disorienting dilemma’ for technology educators, we provide an outline of the ontological frame of reference that dominates technology education curriculum and pedagogy.

1.2 Technology Education as an Ontological Frame

Technology education has its roots in design – creating, making and doing aspects of human activity (Archer, 1979). Often overheard in technology education classes is the “head, heart and hands model” of transformative learning (Orr, 1992; Singleton, 2015). The head, heart and hands model is a holistic approach to developing a transformative experience of learning that relates the cognitive domain (head) to critical reflection, the affective domain (heart) to relational knowing, and the psychomotor domain (hands) to engagement (Singleton, 2015). Technology education and ‘designerly ways of knowing’ is a distinct epistemology separate from scientific and scholarly understandings (Aikenhead, 2021) that helps individuals develop constructive thinking, iconic three-dimensional models of cognition, and a wide range of non-verbal thought and communication skills (Cross, 1982). In the context of this research, TE focuses on developing designerly ways of knowing related to *both digital and physical technologies*.

With the advent of constructivist and constructionist learning theories and low-cost technologies, through the maker movement, TE now enjoys wider acceptance with more effective implementation in schools (Barak, 2018; Bilkstein, 2018). Across international program outcomes, TE has typically fallen under the umbrella of curricula in ‘design and technology,’ ‘career and technology education,’ ‘industrial design,’ or ‘technology and engineering education’ (Brown & Brown, 2010). In British Columbia, TE is found within the *Applied Design, Skills, and Technologies* (ADST) curriculum and:

Involves students in the design and fabrication of products and/or repair and maintenance services using a variety of materials, methods, technologies, and tools...to develop their ability to shape and change materials in the physical world to meet human needs...Using creative and critical thinking, students have the opportunity to work collaboratively to address real-world challenges by exploring materials, using tools and equipment, designing and building, developing processes, and communicating the merits of their work (BCMOE, 2018).

At the secondary level, students in TE engage in a period of user-centred design research and empathetic observation to understand various design opportunities (BCMOE, 2018). Central to the pedagogy in TE is specific, hands-on, experiential learning with multiple design tools and physical equipment. Thus, we hypothesized that the disruption caused by the pandemic declaration and subsequent public health measures would substantially affect the pedagogy of TE teachers and, by association, their students.

1.3 Research Questions

The primary aim of this exploratory research is to examine how the pandemic declaration and the switch to ERT affected TE teachers and how this was a particularly 'disorienting dilemma' (Mezirow, 1991, 2000, 2009). Specifically, we examined the following research questions.

RQ1. How has the switch to ERT affected the pedagogy of TE teachers?

RQ2. How has the switch to ERT affected TE teachers' interactions with students?

RQ3. Does the pandemic and forced switch to ERT constitute a 'disorienting dilemma' for TE teachers?

2. Research Design & Methodology

2.1 Data Collection

Consistent with Braun and Clarke (2006), we employed inductive thematic analysis using data collected using open-ended questions. Following research ethics approval from our institution's research ethics board, the survey was delivered via our local installation of Qualtrics (2020). All participants were presented with written instructions to indicate their consent to participate before proceeding to the online survey. We exported the data to SPSS (IBM Corp, 2020) and NVivo (QSR, 2020) for analysis.

2.2 Participants

The data presented comes from a snowball and convenience sampling of TE teachers in British Columbia, Canada. The research team recruited participants through their professional organization's closed Facebook™ group between 8 and 10 weeks after the pandemic declaration. We recruited a total of 44 secondary specialist TE teachers (excluding two due to missing data). Participants ($N = 42$) included 76% male ($n = 32$), 22% female ($n = 9$), and 2% undisclosed ($n = 1$), with 24% ($n = 10$) under the age of 30, 38% ($n = 16$) between 30 and 40, 26% ($n = 11$) between 40 and 50, and 12% ($n = 5$) over the age of 50. Teaching experience ranged from 1 to 38 years with a mean of 11 ($SD = 9.8$).

2.3 Survey

2.3.1 Demographics

Demographic information collected from each participant included: Age, gender, number of years taught, teaching modality (face-to-face, hybrid, online), and courses they were teaching that they transitioned to ERT. Course subject areas led by the participants at the time of the switch to ERT are identified in Fig. 1.

[Insert Fig. 1 here]

2.3.2 Selected and Open Response Questions

In addition to the demographic survey items, we developed a set of selected response and open-ended questions to precisely capture the characteristics of the classroom context that changed as a result of the COVID-19 pandemic. The selected-response questions aimed at capturing general class characteristics as follows:

Please answer the following based on your experience prior to COVID-19 remote learning.

- What style of teaching did you do? (face-to-face, online, blended)
- How long (on average) were your classes?
- How were you contacting your students (check all that apply)?
- How often did you interact with your students?
- What percentage of your class involves students using tools/equipment/materials?

Please answer the following questions be answered based on your teaching experience during COVID-19 remote learning

- What style of teaching are you doing now?
- How long on average are your classes now?
- How are you contacting your students (check all that apply)?
- How often are you interacting with your enrolled students?

The open-ended questions to capture pre and post-pandemic teaching strategies, opportunities, and challenges are as follows.

- Describe a hands-on assignment you do with your students?
- What would you say is the most challenging part of teaching face to face in a classroom?
- Think back to your hands-on assignment you described earlier. Can you do this assignment through the remote teaching format? Why or why not?
- What is the most challenging part of remote teaching?
- List any issues you or your students have had with the technology involved in the switch to remote teaching?
- What are your concerns about the future of teaching tech ed remotely?

3. Results

3.1 Descriptive Statistics

An analysis of the selected response questions is summarized in Figs. 2–5. Figure 2. presents a comparison between the different instructional modalities TE teachers utilized before the pandemic and once they switched to ERT. As seen in Fig. 2, there was a significant shift in the modality of instruction with the majority ($n = 40$) teaching predominantly face-to-face before the pandemic declaration, with all TE teachers ($n = 42$) transitioning completely to remote online instruction during ERT.

[Insert Fig. 2 here]

Upon transition to ERT, teachers were given access to a suite of technologies and digital learning tools through the Ministry – although support for these tools was uneven across districts, likely because of demand and resourcing issues. Further, the tools made available readily supported pedagogies not necessarily aligned with the needs of many teachers, especially those working in hands-on project-based contexts (for a list, see Anonymous, 2020a). As seen in Fig. 3, there was a significant reduction in average class times, with the majority of teachers ($n = 40$) moving from 60 – 120-minute periods (that included hands-on time with tools and equipment) to 30–40-minute synchronous sessions ($n = 38$).

[Insert Fig. 3 here]

As a result of the modality change, communication methods between teachers and students also changed. Figure 4 highlights the most common communication methods between teachers and students before the pandemic and how they changed due to ERT. Most communication with students before ERT was face-to-face class time ($n = 42$), with some email to support ($n = 23$). During ERT teachers communicated most often through email ($n = 39$), with some video chat ($n = 26$) and phone calls ($n = 25$).

Most notably, in alignment with the public health orders put in place, there was no face-to-face communication.

[Insert Fig. 4 here]

Taking communication one step further, we asked teachers how often they interacted with their students (i.e., having back and forth conversations). Figure 5 illustrates how this interaction changed. TE teachers indicated that they interacted with their students daily ($n = 13$) and several times per day ($n = 24$) before ERT; upon switching teaching modalities, this interaction changed to once ($n = 25$) or twice ($n = 12$) a week.

[Insert Fig. 5 here]

The overall shift in frequency of interaction has become synonymous with ERT as instructional delivery became and, at the time of writing this article, continues to be altered during the ongoing crisis in education that the pandemic has created (Hodges et al., 2020). A thematic analysis of the open-ended questions clarifies how these drastic changes illustrated in this section affected teachers.

3.2 Thematic Analysis

A thematic analysis on each open-ended response to identify patterns and themes in the participants' responses (Braun & Clarke, 2006) was coconducted. The research team collectively identified the relevant themes and agreed upon item placement. Each main theme produced several key themes, and subthemes will be addressed in the following sections. Each item was coded independently by two members of the research team. Cohen's Kappa (κ) was calculated to determine inter-rater reliability. For reference, in relation to a Kappa between 0 and 1: 0 is agreement equivalent to chance; slight agreement is in between 0.1–0.2; fair agreement is between 0.21–0.40; moderate agreement is between 0.41–0.60, substantial agreement is between 0.61–0.80, and near-perfect agreement is above 0.81 (McHugh, 2012; Pallant, 2010). For our research, Kappa was in substantial agreement for themes *teaching challenges before ERT* ($\kappa = 0.75, p < .0005$), *teaching challenges during ERT* ($\kappa = 0.61, p < .0005$), and *technology issues during ERT* ($\kappa = 0.70, p < .0005$). Each key theme and subtheme are presented in Tables 1–3 below. Direct quotes from participants have been edited only for spelling and grammar.

3.2.1 Teaching challenges before ERT

The participants in this study identified existing challenges typical in their classrooms before ERT. The key difficulties (themes) were around: *Access*, *classroom management*, *motivation*, and *learning design*, as indicated in Table 1.

Table 1

Key Themes of Teacher Comments for Teaching Challenges Before ERT

Teaching Challenges Before ERT			
Category Label	Criteria	No ^a	% ^b
Access		6	8.82%
Technology	Access to digital technologies	1	1.47%
Tools & Equipment	Access to tools and equipment	5	7.35%
Classroom Management		18	26.47%
Behavioural Issues	Behavioural issues, challenges with focus or attention	5	7.35%
Distractions	Outside distractions (ex. smartphones)	4	5.88%
Safety	Safety outcomes in the curriculum concerning the use of tools and equipment	9	13.24%
Motivation		19	27.94%
Absences	Absences, missing class, poor attendance	5	7.35%
Student Impatience	Students not exploring learning on their own and expecting teachers to do more	1	1.47%
Engagement	Teacher and student engagement	10	14.71%
Self-Motivation	Students' initiative towards their learning	3	4.41%
Learning Design		25	36.76%
Class Size and Composition	Students enrolled (many students to one teacher), varied grade levels and abilities in one class	19	27.94%
ELL Students	Non-native English speakers challenges with written or verbal instructions	1	1.47%
Non-Traditional Settings	Outdoor classes	1	1.47%
Prep-Time	Time to prep for class	1	1.47%
Prior Education	Students limited prior education in subjects intersecting with technology education	3	4.41%
		68	100%
^a Note: Number of comments coded in this category; ^b Percentage of comments coded in this category			

Access

In this context, as indicated in Table 1, *access* means access to tools and equipment, both hand tools and machinery, and digital technologies necessary for learning. Before ERT, teachers identified existing challenges around accessing modern tools, equipment, and technologies essential for a 21st-century classroom. In particular, some teachers describe “having no tools or books available for myself or students” (Participant 1) and challenges with “getting equipment modernized” (Participant 29) or generally “access to equipment” (Participant 34).

Classroom management

Classroom management is “the actions teachers take to create an environment that supports and facilitates both academic and social-emotional learning” (Evertson & Weinstein, 2006, p. 4). The participants in this study identified: *behavioural issues*, *distractions*, and *safety* as their primary classroom management challenges. Teachers described how students were often distracted by their smartphones. That it was often tricky with larger classrooms as they had to “make sure all students are safe” (Participant 22), in addition to “trying to keep an eye on everyone using machines” (Participant 6).

Motivation

As demonstrated by engagement with a subject, student motivation emphasizes the students’ interest and perceived value of a topic (Lazowski & Hulleman, 2016; Pintrich, 2003). Teachers described issues with absences, student impatience, self-motivation, and overall engagement. While some students have “bad attendance records” (Participant 41), others are not self-motivated or ask for answers without thinking about possible resolutions themselves. Multiple teachers addressed the challenges of keeping students engaged and that they spent considerable time encouraging or ‘winning over’ students:

Becoming adept at ‘winning over’ some of these students really helps. For example, students that skip many of their [other] classes will consistently show up to mine, but it’s a challenge every time. (Participant 38)

Learning design

The learning design of a classroom guides the development of practices based on the needs of students, including modes of instruction (Lieberman et al., 2008). Topics that affected learning design the teachers identified included *class size and composition*, *ELL students*, *non-traditional settings*, *prep-time*, and *prior education* (Table 1). Many teachers expressed concern with the student-teacher ratio, indicating that “not enough of me to go around” (Participant 6). One teacher explained:

There are challenges to a class size of 30 [who are] at all stages of learning. For example, in woodwork, electronics, and drafting, you will see grades 9, 10, 11 and 12 in one class. That [means] a minimum of 4 different courses ... being taught within that one-time slot. (Participant 20)

And another teacher stated that:

In larger classes, splitting my time among students evenly to try and maximize learning during shop time is the most challenging part, especially during independent projects. (Less motivated groups are easier to cover. But my classes tend to have high engagement levels). The independent projects are more taxing on me mentally, but they offer students significant personal achievement. (Participant 38)

Other challenges to the learning design, teachers noted that further consideration to the additional needs of ELL students is necessary, especially for safety, to ensure that “verbal or written instructions are understood” (Participant 18). Further, ongoing challenges in TE involve student recall and integration of other intersecting competencies in subject areas such as math, reading, and writing.

3.2.2 Teaching challenges during ERT

Teachers found that while there were typical classroom issues before ERT, these issues became amplified during the pandemic. Specifically, as indicated in Table 2, key themes include challenges with *curriculum delivery, equity and access, motivation, and policy*.

Table 2

Key Themes of Teacher Comments for Challenges to Teaching During ERT

Challenges to Teaching During ERT			
Category Label	Criteria	No ^a	% ^b
Curriculum Delivery		27	37.50%
Assessment	Assignments or projects (as assigned by the teacher and be completed by students)	12	16.67%
Topics	Types of topics in addition to competency related to technology education elective courses	15	20.83%
Equity & Access		15	20.83%
Access	Access to tools and technology	9	12.50%
Equity	Quality of being fair and impartial	6	8.33%
Motivation		29	40.28%
Engagement	Teacher and student engagement	21	29.17%
Interaction	Teacher and student interaction (communication)	8	11.11%
Policy	Administrative guidance issues	1	1.39%
		72	100%
<i>Note:</i> ^a Number of comments coded in this category; ^b Percentage of comments coded in this category			

Curriculum Delivery

In the ADST BC curriculum, student competency refers to the skills, processes, behaviours, and habits of mind that learners use (BCMOE, 2018b; Gervais, 2016). Specifically, the ADST curriculum aims to foster:

the development of future problem solvers, innovators, service providers, and skilled citizens who can contribute to addressing challenges in our world not ... yet anticipated with processes and technologies not imagined [to] improve their lives, the lives of others, and the environment." (BCMOE, 2018b)

During the earlier stages of the pandemic, teachers expressed concerns with teaching specialized TE topics remotely and with assessment practices. Many of the courses within TE rely heavily on hands-on activities and projects. Teachers detailed the considerable challenges of transforming their hands-on lessons and assignments to online remote delivery and the hours spent finding “resources, materials of value, and compiling them into a satisfying format” (Participant 16). Many described how TE classes are particularly ill-suited to the online remote format. For example, one teacher explained:

Many of the reasons for signing up for a Tech. Ed. class (hands-on work, a physical project to take home, the teacher) are not the same or entirely missing from online learning. (Participant 2)

Another teacher stated that online work “does not mirror the intentions of the curriculum” (Participant 23), which was further complicated by students either not being able to complete assignments because of access issues or motivation.

Equity and Access

TE teachers reflected on students’ access to materials typically provided within classroom settings before ERT, describing how their students now “cannot use tools and software they were using before” (Participant 15). And most notably that “not all students have access to the same tools or materials at home” (Participant 18). These issues underscore a more significant problem of socioeconomic disparity as some students who live in “rural or poor areas” (Participant 1) are more seriously impacted:

This situation is magnifying inequities between families in my community (Participant 12).

The infrastructure needs to be improved to support rural students without Internet access. (Participant 27)

Motivation

Several TE teachers stated that student engagement was the most challenging aspect of ERT, pointing out that they had low “buy-in,” explaining that “a lot of students have access but aren’t participating” (Participant 8). Further, teachers found it much more challenging to connect and interact with their students remotely. For example, students often declined to communicate by ignoring email or messages, teachers were frustrated and found it challenging to provide one-on-one support. Some TE teachers posited low engagement levels because students “signed up for a skills course and are now getting a knowledge course” (Participant 16). Another teacher explained this dispiriting consequence of ERT:

The Tech. Ed. shops are a haven for MANY kids we work within schools. They are already having trouble connecting in academic classes. Now everything is online ... so they are either doing their best to keep up in ... academic[s] or ... or [are] not engaged at all. (Participant 38)

Further complicating matters, policymakers indicated that students who were ‘on track’ would be promoted to the next grade level. When the Minister of Education suspended all classroom instructions, he stated that “schools will implement a variety of measures to ensure continued learning for students” (Fleming, 2020). However, within the same letter from the Minister, he also stated that “Every student will receive a final mark, and all students on track to move to the next grade will do so in the fall” (Fleming, 2020). Although the Minister’s decision was made compassionately, teachers observed that it ended up diminishing motivation: “Since the government announced that students would be promoted, there is little incentive to demonstrate any new learning” (Participant 4). Another teacher explained the consequences of this announcement in more detail, explaining:

All students know that their mark cannot go down, so unless they are intrinsically motivated and have a stable home life AND consistent access to technology, work completed will be a fraction of the quality completed in schools. I believe this applies to all classes in some regards, but in Tech. Ed. it is particularly challenging due to the lesser importance society in general places on skilled labour, trades, and technician work. (Participant 16)

Policy

Building on the previous theme, as K-12 teachers adapted to these extenuating circumstances, many sought further guidance from their administration and the Ministry of Education. As one teacher states:

The inconsistency of expectations. With no specific guidance and directive from admin and the school board, teachers are using different platforms to connect with students and parents; classes are being scheduled over one another; the lack of understanding [of] “attendance” and participation requirements for students and the general prioritizing of academic courses taking precedence over electives. My specific admin has advised against any activities that use tools of any kind for fear of any liability issues. (Participant 20)

3.2.3 Technology issues during ERT

Topics that emerged around using technology as a mediator of teaching and learning for TE teachers during ERT include *communication, curriculum, digital literacy, equity and access, and outside distractions* (Table 3).

Table 3

Key Themes of Teacher Comments for Technology Concerns During ERT

Technology Concerns During ERT			
Category Label	Criteria	No ^a	% ^b
Communication	Communication or correspondence between teacher and student	2	2.30%
Curriculum		6	6.90%
Assessment	Assignments or projects (as assigned by the teacher and should be completed by students)	2	2.30%
Topics	Types of topics in addition to competency related to technology education elective courses	4	4.60%
Digital Literacy	Understanding technology (devices and software)	6	6.90%
Equity and Access		68	78.16%
Devices and Materials	Access to devices and materials (ex. computers, tools, etc.)	26	29.89%
Internet	Access to the Internet (WiFi, etc.)	16	18.39%
Software	Access to software	11	12.64%
Equity	Quality of being fair and impartial	15	17.24%
Outside Distractions	Outside distractions from school (ex. work, waking up, too many other courses, etc.)	3	3.44%
No Issues	No technology issues	2	2.30%
		87	100%
Note: ^a Number of comments coded in this category; ^b Percentage of comments coded in this category			

Communication

Teachers reported a significant shift in communication methods between teachers and students, as illustrated in Figs. 4 and 5, where teachers struggled to get in contact with some of their students.

I have quite a few students who I have not corresponded with at all, or it is less than once per week. Some students do not have access to technology at home, or what they have does not work with the platforms that I am using. Some students also do not understand how to work certain types of software or files. We have also all had it that when a kid hands something in, we look at it and say to the kid; do that again, or what about this? or finish this question, think about it this way... [It is] much more difficult when they email it to you, and you look at it hours later or even the next day. (Participant 24).

Curriculum

Building upon the curricular challenges identified in the last section, teachers indicated that delivery issues were amplified due to technology challenges. Although TE generally has more hands-on physical projects, teachers indicated that even when they re-designed their lessons towards more digital projects – using technologies, such as YouTube, Zoom, or Microsoft Teams – students were not completing tasks. As illustrated in the previous section under *motivation*, many noted that the policy changes were likely a diminishing factor.

Digital Literacy

Digital literacy involves “technical, cognitive, and sociological skills to perform tasks and solve problems in digital environments” (Eshet, 2004, p. 93). Teachers described students’ issues with “remember[ing] passwords and sign-ins. For some, computer technology is not their thing, and it’s a big learning curve for them” (Participant 6). For others, they had students unfamiliar with basic computer literacy skills like “copying and pasting links, how to properly use search engines, etc.” (Participant 13).

Equity and Access

Teachers identified considerable equity and access to technology problems, including *devices, materials, Internet, and software*, compounding the issues identified earlier. The majority of teachers made comments about the limited access to devices and materials. Whether it was that “many have no access or time as families are trying to share devices or do not have reliable” (Participant 23) or it was that there were shared devices within one household with some having no access at all. One teacher said,

“Some students have one computer for up to 7 ... in a household. Some don't have access to any tools at all” (Participant 5)

Another teacher described the challenges they faced:

My personal laptop died two days ago, and I had to pay to have it repaired. I had to limp along with my iPad and iPhone to teach. I have a district computer, but the specialized software that I need doesn't work remotely. (Participant 30)

Internet connectivity and reliability further complicated issues as some teachers pointed to limited WiFi in remote locations or slow Internet speeds. One teacher described how some “students hav[e] limited Internet data plans at home (no *YouTube, TinkerCAD* or *Zoom*)” (Participant 34). Complications emerged with specialized software necessary for some TE courses such as AutoCAD and RobotC:

There is limited access to a high-performance computer and licensed software. Many of the projects that “could be done from home” can only be completed by about 10% of my students. (Participant 2)

These issues were further amplified based on socioeconomic disparities. Students in more rural areas or living on First Nations reserves were struggling. Many of their students have “unstable home lives”

(Participant 38), and some families were not worried about school but dealing with “crisis related to food and lodging” (Participant 4).

4. Discussion

As discussed earlier, technology education is founded primarily in design – creating, making and doing aspects of human activity (Archer, 1979). Central to this approach is the “head, heart and hands model” of transformative learning (Orr, 1992; Singleton, 2015) – a holistic approach to developing a transformative experience of learning that relates the cognitive, affective, and psychomotor domains to the head, heart, and hands respectively. (Singleton, 2015). Alongside this, Cross (1982)’ seminal workaround ‘designerly ways of knowing’ points to the centrality of non-verbal modes of communication in what he describes as the ‘third culture’ of design (as distinct from numeracy and literacy). It is no surprise then that the pandemic declaration and the switch to ERT profoundly affected TE teachers, as our research clearly illustrated. From a theoretical standpoint, the thrust of Mezirow’s transformative learning theory is supported – particularly the emphasis on meaning-making from a disorienting dilemma. We will now turn to a discussion of our findings and address each of our research questions.

4.1 How has the switch to ERT affected the pedagogy of TE teachers?

4.4.1 Curriculum prescribed competencies are a casualty

In the context of this research, the subject matter TE teachers were focused on was deeply embedded in developing ‘designerly ways of knowing’ (Cross, 1982) related to *digital and physical technologies*. Since the curriculum the TE teachers were following was meant to mediate – or negotiate – between the physical aspects of making and doing and design and creative problem solving using digital media, the biggest challenge they faced was making and doing. Our research demonstrates that TE teachers did their best to adapt their pedagogy to meet student needs during these extenuating circumstances. However, some of the curriculum prescribed competencies around physically making and doing became a casualty, while others that involved the digital design and creative problem solving offered opportunities, concluding that there was a *pandemic transformed pedagogy* in TE. For example, in the Technology Explorations course, one of the outcomes requires students to consider mobile devices’ social, cultural, and economic impact (BCMOE, 2018). This particular outcome could be readily adapted to a technology-mediated pedagogy. However, in the same Technology Explorations course, students are also meant to develop metalworking techniques and processes competencies using hand tools and power equipment (BCMOE, 2018). Given the issues with safety, equity, and access to tools and technologies, this prescribed outcome could not be achieved and, consequently, was a casualty.

As many of our TE participants described, most TE electives are designed around the hands-on development of physical projects. As the pandemic circumstances continue to shift, educators, administrators, and policymakers may wish to develop or continue blended or hybrid learning

opportunities (e.g., Zitter & Hoeve, 2012; Zitter et al., 2009). However, the TE teachers in this research expressed concerns about the future of technology education as a profession if this hybridity were to become the norm (For a discussion of these findings, please see Anonymous (2020a)). Despite TE teachers recognizing that the majority of their students take TE courses to develop hands-on designerly competencies, several of our participants lamented that their courses are “not transfer[ring] well to online settings” (Participant 26). In contrast, others began to reflect upon and rethink aspects of their pedagogy.

4.4.2 Pedagogy reimaged

Our research reinforces that teaching in online, blended, or hybrid learning modalities requires a significant reimaging and re-design of the pedagogy educators use (Jonassen, 2006; Kanuka, 2006). The shift to ERT impacted the curricula. The content TE educators taught required a change in actions, judgements, and the selection of teaching strategies (Jonassen & Land, 2014), leaving many teachers ill-equipped to deal with these new circumstances. As we have illustrated, TE teachers’ *pandemic transformed pedagogy* left many outcomes behind. Particularly those connected to three-dimensional models of cognition (Cross, 1982), interrupting the holistic approach to the learning experience (head, heart and hands) most often engaged in the TE context (Singleton, 2015).

TE teachers often spend time in class instructing students on equipment safety or performing demonstrations using various tools. Much of this work was ‘just-in-time’ and often personalized to each student as they progressed according to their competency level. When the current provincial curriculum was introduced, there was an emphasis on personalized learning—in particular, focusing on “enhancing student engagement in learning and giving students choices and more of a say in what and how they learn—leading to lifelong, self-directed learning. Students and teachers develop learning plans to build on student’s interests, goals, and learning needs” (BCMOE, 2015). Our participants thus spent a great deal of time developing YouTube videos that they recognize are inherently valuable in their ability to save instructional time and offer ‘just-in-time’ resources for students to review at their own pace. However, despite the inherent value, many participants found that developing these videos for students to view was “time-consuming and not what kids signed up for” (Participant 16).

4.2 How has the switch to ERT affected TE teachers’ interactions with students?

4.2.1 Obstructed Engagement

I have quite a few students who I have not corresponded with at all, or it is less than once per week. Some students do not have access to technology at home, or what they have does not work with the platforms that I am using (Participant 24).

Many teachers reported that, during the pandemic, there was a marked decrease in engagement from their students. Factors contributing to this were manifold, including the access challenge addressed below. However, the main demotivating factor that teachers pointed at was the lack of embodied

experiential learning, a significant component of technology education. Notably, the sentiment that the ERT experience was “not what the students signed up for” in that one of the attractions of TE is the hands-on skill-based experience that was replaced, in many cases, by far greater focus on more theoretical text-based learning. As an analogy, in the same way that someone who signed up for in-person swimming lessons would be disappointed (and dismayed!) to learn later that the classes would take place online, TE student engagement suffered because the essential embodied component of the activity was absent. The ‘final straw,’ as it were, was the Ministry’s announcement that, essentially, all students would be promoted which, significantly devalued any additional effort students made in their coursework.

4.2.2 Undermining equity and access

Equity and access to learning for all seem relatively straightforward, as “any society committed to promoting equity must ensure that their education system...is accessible to students from the broadest spectrum” (Salami & Bassett, 2014, p. 362). Further:

Equity is defined as providing equal opportunities for access and success ... [Which] means that circumstances beyond an individual's control ... should not influence a person's access...equity is not about treating everyone exactly the same but about providing interventions that promote equality of opportunity. (Salami & Bassett, 2014, p. 365)

Equity and equality of opportunity were completely undermined during the COVID-19 pandemic. It was very apparent through the TE teachers’ comments that equity and access were the most alarming limiting factors, which the overwhelming majority were concerned about, as illustrated by the following participants.

“Some students have one computer for up to 7 ... in a household. Some don't have access to any tools at all” (Participant 5).

“Students hav[e] limited Internet data plans at home (no YouTube, TinkerCAD or Zoom)” (Participant 34).

The digital divide – an identifying factor between the haves and have-nots of people between upper and lower-income levels (Hoffman et al., 2000) – was brought to the forefront and caused considerable moral trauma to our participants. Despite scholars espousing that we are in our secondary information age (Iranga, 2016), teachers could not have presumed that their students possessed the requisite digital literacy, an issue compounded by equity and access to tools, devices, and connectivity critical for student success. We need to consider “designing and implementing policies aiming to remove systematic differences in...education opportunities for groups and individuals who differ only in terms of their place of birth or residence, ethnic or cultural origin, gender or because of disabilities” (Salami & Bassett, 2014, p. 365).

4.3 Did the pandemic and forced switch to ERT constitute a ‘disorienting dilemma’ for TE teachers?

Our research presents data from a survey identifying TE teachers' perspectives of their pedagogical shift to ERT. Through the lens of Mezirow's transformative learning theory and our survey results, we argue that the pandemic and switch to ERT has a 'disorienting dilemma' for TE teachers.

On the face of it, the sudden transition to ERT was a clear case of a disorientating dilemma for K-12 teachers, given that it forced them to assess so many of the things that they, as teachers, had taken for granted. Firstly, their training and experience had not prepared them for a sudden switch to remote teaching. So much of K-12 education is structured around the bricks-and-mortar of the school environment. From classrooms, desks, locker, bells, books, and Bunsen burners, "schools" as we conceived of pre-pandemic was for almost everyone a *place* rather than an activity. Suddenly, "going to school" ceased to be a physical relocation for both teachers and students. Instead, the first challenge was negotiating the new conceptual challenge that "school" was now the same as "home." Of course, this is entirely different from homeschooling. Teachers were "working from home" and "living at work," which was compounded by the challenges of teaching in a new modality and attempting to engage with their learners – who were similarly struggling with this dislocation of the locus of learning.

In addition, teachers' fear about their career prospects and concerns that the pandemic might see enrollment in TE dropping to levels that threaten the viability of programmes in schools is a component of a disorientating dilemma. Similarly, teachers struggling to establish and maintain a connection with their students and regularly teaching "into the void" through MS Teams or Zoom, not knowing how much, or even if, their students are finding the learning experiences valuable. Uncertainty can be demoralizing for teachers and students alike: "feeling ashamed of being disoriented might be accompanied by fear, loss and (anticipatory) grief, not knowing how to cope with the current crisis" (Eschenbacher & Fleming, 2020). Given this uncertainty, one might argue that this trauma alone constitutes an ongoing disorientating dilemma for educators.

5. Limitations And Future Research

There are some limitations to this study, including a sampling and selection size, and bias and limited previous research studies on this topic. In particular, with a smaller sample size ($n = 42$), it is difficult to generalize the results to a larger population. Further, the current sample is a specialized group. Future research could extend to include all secondary teachers to compare across subjects and rural, suburban, and urban school districts. Longitudinal studies could compare global responses, especially as each country and community made different pandemic-related decisions. We hope our study can inform future research examining the disorienting conditions of the pandemic and whether pedagogical and systemic changes remain episodic or have more prolonged effects.

6. Conclusion

"An educator may set out to disrupt comfortable world views held by participants as in the practice of 'ideology critique,' ... In other instances, the 'disorienting' is generated by an external event, such as a

personal illness, the loss of a job, or cultural dislocation ... The educator in these circumstances operates on the border between therapy and education, assisting learning to search for meaning, however tentative and fragile. Such a stance draws more appropriately from traditions that acknowledge the intuitive, nonrational ways of being and studies that are conducted in highly emotionally charged contexts.” (Sands & Tennant, 2010).

This research was conducted during the earlier stages of the “stay at home” mandate. We wanted to capture the experience and feelings of TE teachers during the very challenging ERT time. We highlighted the challenges TE teachers faced as they made their best attempts to offer a stable learning environment for their students while negotiating challenges around technological and socioeconomic disparity, alongside the accompanying challenges around motivation and engagement. We recognize that COVID-19 will continue to have a more significant impact on our education system. As we move through the next school year, schools find a balance for teachers and students and the pedagogical challenge of delivering curriculum in the “new normal.” While we can’t predict what the “new normal” will look like for schools, what the long-term effects of ERT will have, our research demonstrates that the disorienting dilemma COVID19 presents will continue to shape the pandemic transformed pedagogy of technology educators.

Declarations

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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Figures

Figure 1

Courses Taught by Participants. Note. Some participants indicated teaching multiple courses

Figure 2

Mode of Teaching Before and During ERT

Figure 3

Average Class Length Before and During ERT

Figure 4

Communication with Students Before and During ERT

Figure 5

Interaction Frequency Between Teachers and Students Before and During ERT