Pandemic designs for the future: perspectives of technology education teachers during COVID-19

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Received 12 April 2020
Revised 10 May 2020
1 June 2020
5 June 2020
13 June 2020
17 June 2020
Accepted 17 June 2020

Abstract

Purpose – The disruption caused by the pandemic declaration and subsequent public health measures put in place have had a substantial effect on teachers' abilities to support student engagement in technology education (TE). The purpose of this paper is to explore the following research question: How do TE teachers see emergency remote teaching (ERT) transitions to blended learning into the next academic year affecting their profession?

Design/methodology/approach – A snowball and convenience sampling design was used to recruit specialist teachers in TE through their professional organization and were asked to respond to the question: What are your concerns about the future of teaching TE remotely? The qualitative data collected from the participants (N = 42) was analyzed thematically (Braun and Clarke, 2006).

Findings – The analysis revealed that the switch to ERT impacted the teachers' ability to support hands-on competency development owing to inequitable student access to tools, materials and resources, all of which affected student motivation and engagement. As a result, teachers raised questions about the overall effectiveness of online learning approaches and TE's future and sustainability if offered completely online.

Originality/value – This research is the first of its kind exploring the experiences of TE teachers during the COVID-19 pandemic. In answer to the challenges identified by teachers, the authors offer a blended learning design framework informed by pandemic transformed pedagogy that can serve as a model for educators to use when designing blended instruction.

Keywords Secondary school, Technology education, Trades, STEM, Engineering, Pandemic transformed pedagogy, COVID-19, Remote teaching, Online learning, Hybrid learning, Blended learning, Teacher perspective

Paper type Research paper

1. Introduction

On March 11, 2020, the WHO Director-General declared SARS-CoV-19, the novel coronavirus that causes the COVID-19 infection, a pandemic, leaving the global community

The authors would like to thank the British Columbia Technology Education Association and the technology education teachers for participating in this research. We would also like to acknowledge the UBC Technology Education teacher candidate class of 2020 and Dr Samson Nashon and Kerry Renwick for their insightful feedback on drafts of this manuscript.

This article is part of the special issue, "A Response to Emergency Transitions to Remote Online Education in K-12 and Higher Education" which contains shorter, rapid-turnaround invited works, not subject to double blind peer review. The issue was called, managed and produced on short timeline in Summer 2020 towards pragmatic instructional application in the Fall 2020 semester.

Funding: Jillianne Code is supported in part by the Social Science and Humanities Research Council of Canada (430–2016-00480).

Information and Learning Sciences
Vol. 121 No. 5/6, 2020
pp. 419-431

2398-5348
DOI 10.1108/ILS-04-2020-0112

to respond post-haste (WHO, 2020). In the weeks following this declaration, K-12 school systems around the world suspended classroom-based operations in response to public health officials' declarations of emergency (BCMOE, 2020b, 2020c). In British Columbia (BC), a geographically and socially diverse province in Western Canada, this declaration affected around 44,000 teachers and almost 600,000 students (Hyslop, 2020a, 2020b). As a result, a paradigm shift in pedagogy was necessary to allow for all teaching and learning activities to be conducted online using emergency remote teaching practices (ERT) (Hodges, *et al.*, 2020).

ERT involves a "temporary shift of instructional delivery to an alternate delivery format due to crisis circumstances" (Hodges, *et al.*, 2020). During non-emergency situations, a successful shift to completely online and blended learning requires a significant re-imagining. This entails a re-design of the pedagogy educators use because the mode of instructional delivery impacts not only the curricula and content educators teach but also their actions, judgements and selection of teaching strategies. It is within this "in-between" context that we examine teachers' responses to the pandemic, using Mezirow (1978, 2006) conception of transformative learning. This paper reports on teachers' perspectives on teaching technology education (TE) entirely online during ERT, considerations they identified as necessary for a likely transition to a blended learning scenario in the next academic year and their concerns about the potential long-term impact this may have on TE. To contextualize this research, an overview of TE in the context of the BC Ministry of Education (BCMOE) curriculum is provided.

2. Background

TE enables students to develop the ability to design and apply skills to make projects, or products, using a variety of digital and physical technologies. However, the answer to the question "What is technology education?" has changed over the past several decades (Brown and Brown, 2010). The conceptual understanding of technology education has long been conflated. Individuals who look at technology *in* education may see educational technology, information and communication technology (ICT), and technology education or trades, with elements of design, applied across disciplines from art to science (Petrina, 2007). The emergence of the maker movement has further blurred TE lines, as maker spaces typically possess elements of shop class, home economics, art studios and science labs – emerging as both informal (e.g. museums, libraries) and formal learning environments (Dougherty, 2013; Schad and Jones, 2020). Along with home economics and culinary arts, ICT and business education, TE completes the applied design, skills and technologies (ADST) component of the BC Grade 10–12 curriculum, which builds on "students' natural curiosity, inventiveness and desire to create and work in practical ways" (BCMOE, 2018a, 2018b, 2018c). For the purposes of this research TE involves:

> Students in the design and fabrication of products and/or repair and maintenance services using a variety of materials, methods, technologies, and tools in order to develop their ability to shape and change materials in the physical world to meet human needs (BCMOE, 2018a).

Through TE, students gain significant specialized experience applying creative critical thinking and problem-solving in the physical world to address real-world challenges that have broad application across many sectors of the economy. At the secondary level (Grades 8–12), students develop the competencies in TE that prepare them for a variety of careers across STEM and trade fields. For example, learning outcomes in machining and welding 12 include developing an understanding of the machining and welding processes in industry including how to use a MIG welder, which is used to join a wide range of metal thicknesses (BCMOE, 2018b). Such welding skills are integral to careers in robotics, engineering, aerospace, automotive technology and industrial fabrication, to name just a few. TE enables

students to develop the competencies in design thinking necessary to fully engage in the 21st-century economy.

2.1 Aims

Experiential hands-on learning is a central teaching and learning strategy in TE and requires access to various design tools (e.g. computer-aided design) and equipment (e.g. band saw, drill press and vinyl printer). We hypothesized that the disruption caused by the pandemic declaration and the subsequent public health measures put in place would have a substantial effect on teachers' abilities to support student engagement in TE. The aim of our research project is to investigate the effects of the COVID-19 pandemic-related shift to ERT on secondary teachers, with a specific focus on TE in the secondary setting (Ralph *et al.*, 2020). For the purposes of this paper, we explore the following research question:

RQ1. How do TE teachers see ERT transitions to blended learning into the next academic year affecting their profession?

3. Methods

3.1 Context

In late March 2020, the BCMOE released the *integrated planning framework for school districts and independent school authorities*. School districts were issued with information around how districts were to provide a continuity of educational opportunities and of support, recommending "that schools and school districts provide initial training and support to teachers and families during this transition" (2020c). At around the same time, the *continuity of learning planning guide for teachers* was released, with information on selecting and using digital learning tools, listing Zoom, Microsoft Teams, Google Classroom, Moodle, Canvas, MyEd BC and FreshGrade as potential options (BCMOE, 2020d). This study presents results based on the first two months of ERT, during which teachers dealt with the shift to online teaching, highlighting the opportunities and challenges they faced.

3.2 Participants

Participants in this study were secondary TE teachers in British Columbia, Canada, who were asked to participate in an online questionnaire through the University of British Columbia's installation of the Qualtrics (2019) online survey software platform. Using snowball and convenience sampling, these specialist teachers were recruited through their professional organization's closed Facebook group 8–10 weeks after the pandemic declaration.

The study recruited a total of 42 secondary specialist TE teachers (excluding two, owing to missing data). Participants ($N = 42$) comprised 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 ($SD = 9.8$). Subject areas taught by the participants at the time of the switch to ERT are identified in Figure 1.

3.3 Data collection

The *RQ*: *How do TE teachers see ERT transitions to blended learning into the next academic year affecting their profession?* was examined using teachers' responses to the following open-ended question: *What are your concerns about the future of teaching TE remotely?*

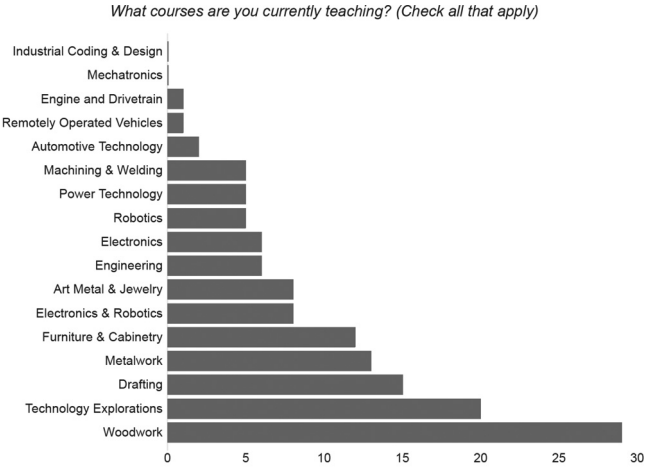

Figure 1.
High school technology education courses taught by participants

Note: Each participant may have indicated that they taught multiple courses

3.4 Data analysis

A thematic analysis (Braun and Clarke, 2006) was conducted whereby the two authors (JC, RR) familiarized themselves with the responses, generated initial codes and organized the data into overarching key themes and subthemes. This process was data-driven and thus was inductive in nature. The authors (JC, RR) iteratively compared their analyses and coding and came to a consensus.

4. Results

4.1 Key themes

Analyses for the RQ addressed in this paper revealed five key themes including student competency in TE; equity and access; motivation; effectiveness; and sustainability. Each key theme was further divided into sub-themes. The coding scheme used to categorize teacher comments about the future of TE and learning online is outlined in Table 1; examples of comments made by TE teachers are in Table 2. Direct quotes from participants below are indented, indicated in italics and have been edited only for spelling and grammar.

4.1.1 Theme 1: curriculum (25%). Student competency represents the combined skills, processes, behaviours and habits of mind that learners use to make sense of the world (BCMOE, 2018c; Gervais, 2016). In TE, the competencies students develop extend from various design approaches, hands-on skills and the safe use of tools and make up the most significant portion of the curricular outcomes.

Comments from teachers referred specifically to the aspects of the curriculum that they were successful at transitioning to ERT, for example, TE teachers refer to knowledge-based concepts as "theory", which many reported they were successfully able to transition online. However, it was the "hands-on" or "doing" aspects of the curriculum, especially in the more specialized context (i.e. machining and welding) that were especially challenging:

> For the most part, we are not able to teach the most important parts of the curriculum. We can teach theory, or use online simulations for some subjects, but the hands-on skills are lost. DOING

Category label	Criteria
Competency in TE	
Skills	Refers to the development of hands-on skills and competency outcomes in the curriculum
Safety	Refers to the safety outcomes in the curriculum with respect to the use of tools
Topics	Refers to the types of topics in addition to competency and safety outcomes in the curriculum
Effectiveness	
Positive	Refers to positive comments about remote and/or online learning
Negative	Refers to negative comments about remote and/or online learning
Equity and access	
Equity	Refers to the quality of being fair and impartial
Access	Refers to access to tools and technology
Motivation	
Engagement	Refers to teacher and student engagement
Interaction	Refers to teacher and student interaction
Sustainability	
Community	Refers to impacts on the broader community
Enrollment	Refers to impacts on student enrollment in TE
Feasibility	Refers to the feasibility of delivering TE using remote and/or online learning
Job security	Refers to impacts on teacher job security

Table 1.
Key themes of teacher comments about the future of technology education and learning online

> is such a big part of tech ed, and that is very difficult with remote learning. (Emphasis in the original comment, Participant 14)

> My personality and presence are what engages the students. Teaching tech is almost like a performance piece. Movement, how you hold a tool, how you walk and stay on the balls of your feet, push through a table saw, etc. etc. (Participant 9)

Many teachers also expressed concerns about their students' safety using even the simplest hand tools at home (Ralph *et al.*, 2020). Teachers had particular concerns with the safe use of tools if teaching remains completely online:

> A major part of learning that students don't otherwise get in other courses will be lost. The hands-on activities play a role in teaching students safety and finding satisfaction in non-digital work. (Participant 42)

Overall, the opportunities for TE teachers to help students develop competency with hands-on skills and the safe use of hand tools and machines were limited, as most tools were not commonly available in most homes. Teachers felt that this lack of universal access to tools may lead to a lasting impact on TE – "I'm afraid that students won't get the hands-on experience, and therefore won't get to develop the passion for our subjects" (Participant 32).

4.1.2 Theme 2: equity and access (26%). Circumstances beyond an individual's control should not influence a person's access to educational opportunities (Salami and Bassett, 2014). In Ralph *et al.* (2020), teachers described challenges around connecting with students whose family had only one device and limited internet access. As a result of the switch to ERT, comments expressed concerns with equity and the challenges facing some of their students:

> This situation is magnifying inequities between families in my community, and assigning a mark based on worksheets isn't fair to my students who struggle with reading/writing but excel with hands-on work. (Participant 17)

Category	No.[a]	(%)[b]	Sample comments
Curriculum	*25*	*25.3*	
Competency in TE	17	17	Hands-on work is an integral part of what we teach and without our support and supervision, many students will not get the experience of hands-on work
Safety	4	4	They shouldn't be working with power tools alone
Topics	4	4	For the most part, we are not able to teach the most important parts of the curriculum
Effectiveness	*12*	*12.1*	
Positive	3	3	We can teach theory, or use online simulations for some subjects
Negative	9	9	Tech ed cannot be fully converted to remote learning
Equity and access	*26*	*26.3*	
Equity	4	4	This situation is magnifying inequities between families in my community
Access	22	22	Many aspects of what makes tech ed classes unique rely on access to equipment that students likely do not have at home
Motivation	*15*	*15.1*	
Engagement	14	14	Kids want shop classes because they want to be active and learn by making and doing
Interaction	1	1	Important to have face to face interaction
Sustainability	*21*	*21.2*	
Community	3	3	I am not concerned with my school and district - we are tied to a smaller community that respects and requires skilled workers
Enrollment	6	6	I hope that this does not continue past October. If so, we are likely to see a serious decline in our numbers
Feasibility	7	7	It's not feasible
Job security	5	5	That the government will cut funding to Tech Ed programs
	99	100	

Notes: [a]Number of comments coded in this category; [b]per cent of comments coded in this category.

Table 2. Qualitative comments from teachers

The majority of TE students do not have the required machinery and specialized equipment at home, though access to the appropriate tools and technologies forms an essential part of building knowledge, skills and attitudes in this area. Thus, the negative impact on the competency and skills development aspect of the curriculum was magnified. A significant number of comments were associated with equity of access to specialized tools, as illustrated by the following perspective:

> Many aspects of what makes tech ed classes unique rely on access to equipment that students likely do not have at home, and in-person instruction. Remote learning has a lot to offer, especially in a blended model, but tech ed cannot be fully converted to remote learning. (Participant 2)

4.1.3 Theme 3: motivation (15%). With an emphasis on perceived value for and interest in an activity (Lazowski and Hulleman, 2016), student motivation is demonstrated by their engagement in a subject and how they direct their behaviour (Pintrich, 2003). Several teachers commented about the level of engagement of their students and that it is "important to have face to face interaction" (Participant 13). Specifically, teachers identified a substantial drop-off in engagement and attendance following the switch to ERT:

> It's one thing to know your students for 8 months before going remotely, but not knowing your kids, i.e.: September would be really hard. I'm having these issues with my newest rotation of

> ADST 8. I've only met with them twice before spring break – this class has the lowest attendance and participation from all my classes. (Participant 11)

While it is difficult to know for certain what caused the change in motivation and engagement, it can be surmised that pre-existing differences in student situations at home, across schools and districts were amplified as a result of the pandemic and likely played a role. The Organization for Economic Co-operation and Development (OECD) commissioned a study aimed at supporting education decision-making during the COVID-19 pandemic completed in March 2020 that highlighted:

> Differences among students in their resilience, motivation and skills to learn independently and online, are likely to exacerbate already existing opportunity gaps (Reimers and Schleicher, 2020).

Additionally, a mid-March announcement from the BCMOE, which reassured the public that all students who were on track to finish at the time of the pandemic declaration would be allowed to graduate or would be advanced to the next grade level (Mangione, 2020) likely had an effect on student motivation and engagement.

4.1.4 Theme 4: effectiveness (12%). Building upon what teachers have identified thus far as to what is important to TE, some teachers did find that "remote learning has a lot to offer, especially in a blended model" (Participant 10):

> It is impossible to do hands-on work such as woodwork online due to a lack of tools and major safety concerns. [However,] one could do all the power tool safety orientation online using videos and quizzes and perhaps a module on hand drafting and design. (Participant 19)

But many teachers could not overcome the myriad challenges affecting issues of tool access in this context: "you cannot replicate tactile and kinesthetic skills under the supervision of a trained instructor online" (Participant 12). Some teachers added additional concerns about costs and infrastructure:

> It is less effective and engaging for students, moving metalwork related courses online. Hands-on skills need to be developed using tools rather than watching someone else use tools. The infrastructure needs to be improved to support rural students without internet access. My biggest concern is that in-class instruction will be phased out over time in order to save costs. (Participant 37)

4.1.5 Theme 5: sustainability (21%). Achieving sustainability in TE, meeting the needs of the present without compromising the future, is a challenge at the centre of much educational practice (Frisk and Larson, 2011). During the present time of upheaval, teachers are being asked to adopt different values, attitudes, habits and behaviours to overcome the current challenges in education without having a concrete sense of what comes next. This final key theme reflects the thoughts teachers had about the future if the disruption to regular teaching practice is prolonged:

> I'm afraid that students won't get hands-on experience, and therefore won't get to develop the passion for our subjects. Ultimately this could lead to a labour and trades/technology shortage. (Participant 32)

Further, in addition to the overall sustainability of TE, teachers had concerns about enrollment and the feasibility of teaching TE completely online:

> That after trying to build up our school's ADST programs for 3 years, all of it will be in vain due to a lack of preparation, foresight, and time to deal with the changes that are faced with remote learning. (Participant 13)

Finally, teachers had concerns about access to funding to maintain and improve their instructional approaches and for students to participate equitably: "Will the school[s] be able to provide both students and teachers with the necessary technology to continue teaching online?" (Participant 40)

Teachers that offer elective courses, such as those in TE, face concerns of being laid off if students do not sign up for their courses. These fears lead some participants to have concerns about their job security:

> I'm worried we will be considered surplus if this continues on - as a [newer] teacher I've already been laid off and am worried there won't be my job to reapply for next year. (Participant 3)

4.2 Final thought

One comment in particular encapsulated the teachers' feelings about the experience of switching to ERT and the concerns they had for the future of TE and the potential long-term effect on the broader community:

> A major part of learning that students don't otherwise get in other courses will be lost. The hands-on activities play a role in teaching students' safety and finding satisfaction in non-digital work. It will also reduce the already thin blue-collar workforce, as students will not be prepared to enter trades fields without any practical experience in a shop. Student enrollment will decline if this is prolonged, as most students do not want to do only theory work in a predominantly hands-on course. (Participant 42)

5. Discussion

The purpose of this study was to investigate the effects of the COVID-19 pandemic related shift to ERT on secondary teachers, with a specific focus on TE. Five themes emerged from the data: student competency, equity and access, motivation, effectiveness and sustainability. We will focus a brief discussion of the themes through the lens of Mezirow (1978, 2006) transformative learning theory, offer recommendations for practice using a blended learning framework and provide some suggestions for future research. For a fulsome exploration of this and other findings please also see Ralph *et al.* (2020).

5.1 Implications for theory

The participants in this research have found themselves at the cusp of a rapid change that is compelling them to re-think their worldview in both how they teach and how their students learn, necessitating their transformation as educators. From the perspective of critical pedagogy, transformative learning (Mezirow, 1978, 2006) in the context of this research – and arguably beyond – has forced educators to experience a deep structural shift in thought and action (O'Sullivan and Morrell, 2002). The implications of the emergency transition to remote teaching we describe as *pandemic transformed pedagogy* is illustrated through our thematic findings as follows:

- Curriculum-prescribed competencies are a casualty in pandemic transformed pedagogy.
- Equity and access to learning for all is undermined by pandemic transformed pedagogy.
- Pandemic-transformed pedagogy inhibits learning of unmotivated students.
- Pandemic-transformed pedagogy has novelty, as well as limitations, in terms of effectiveness.

- Educators' fears of loss of sustainability and quality of teaching are magnified by pandemic transformed pedagogy.

To mitigate the effects of pandemic transformed pedagogy, we turn to a framework of blended learning, where learning design recommendations for practice are offered as ways to overcome the myriad challenges TE teachers faced during ERT.

5.2 Recommendations for practice – a learning design framework

> The emergence of blended learning environments is driven by changes in educational practice. Established educational practices are changing: established roles, resources and locations are being altered, extended and replaced. (Zitter and Hoeve, 2012, p. 5).

Within the learning sciences, the context of education has extended the learning environment beyond the formal classroom to include informal and workplace settings (Engeström, 2009), a sentiment also reflected in the library science and museum education literature (Koh and Abbas, 2015; Schad and Jones, 2020). An expansive definition of a learning environment includes elements of the physical and digital setting (e.g. tools, documents and artifacts) where learners carry out learning tasks and activities in a sociocultural context (Goodyear, 2001). The combination of the physical and digital setting has particular salience in TE, along with an emphasis on the authenticity of the learning task to be performed by students (De Bruin and Leeman, 2011). We recommend using the following modified learning design framework developed by Zitter and colleagues (Zitter *et al.*, 2009; Zitter and Hoeve, 2012). As authentic tasks emerge from professional domains, as in the case of TE, the "learning environment can be unravelled into separate authentic tasks analytically but must remain part of an intact whole" (Zitter and Hoeve, 2012, p. 11). Once learning tasks are separated, they should then be viewed from several different perspectives: agency, spatial, temporal and instrumental. Along with a definition of each of these perspectives, in Table 3, we provide an example of how this framework can be applied as guidance so that TE teachers can make appropriate instructional decisions to transition successfully into a blended model of learning to fully capitalize on the opportunities of a pandemic transformed pedagogy.

5.3 Future research

Until adequate treatments for the COVID-19 infection are found, educators across all levels may need to find solutions to support learners at a distance for the foreseeable future. In BC, preparations are underway for the implementation of piloting a blended model of instruction where students do substantive portions of their TE coursework at home and rotate through the TE facilities in smaller groups for in-class hands-on learning (BCMOE, 2020a). As illustrated, a blended model for TE informed by pandemic transformed pedagogy is possible within the constraints described in this analysis and in our parent project (Ralph *et al.*, 2020). Further, it is well established that blended models of instruction provide significant opportunities to incorporate flexibility, stimulate interaction, aid in facilitating student learning and improve affective learning (Boelens *et al.*, 2017; Hodges *et al.*, 2020). Even when a complete return to the physical school is possible, a blended approach to TE may be favourable in the longer term and future research might beneficially examine this question. In addition, questions of program sustainability should also be explored to critically examine how TE can effectively engage as a core STEM education subject area (Strimel and Grubbs, 2016).

Design perspective	Question/definition	TE example: machining and welding 12
Authentic backbone	*What is the task to be performed?*	Learning outcomes in machining and welding 12: developing an understanding of the machining and welding processes in industry including how to use a MIG welder which is used to join a wide range of metals and thicknesses (BCMOE, 2018a, 2018b, 2018c)
Agency perspective	*Who is active in the learning environment?* Roles enacted by the students (e.g. apprentice welder) and teacher (e.g. mentor and master welder)	Student: learner, apprentice welder Teacher: mentor, master welder
Spatial perspective	*Where does learning take place?* The physical and digital spaces in which the task takes place	Digital: understanding the machining and welding processes in industry; including an overview of procedures and safety Physical shop: How to *safely* use a MIG welder including the specific procedures required; How to move your hands/arms and body when manipulating materials and using tools
Instrumental perspective	*Which tools are used?*/The boundary objects (tools) that are instrumental to the completion of the task	Digital: internet access, computer, learning management system, video, images, web sites, other online resources. Physical shop: MIG welder, safety equipment, metal materials
Temporal perspective	*When does the learning take place?*/ The timeframe relevant to the task	Students must *first* have an understanding of the machining and welding process before they learn how to use a MIG welder in the shop. Students must also repeatedly practise how to perform these skills in order to develop competency
Quick wins	*Can paper or a digital artifact be used?* For example, in carpentry, could cardboard be used as a substitute for wood? In drafting, is there free online software that could be incorporated? In robotics, are there online simulations available?	Digital: understanding the machining and welding processes in industry; including an overview of procedures and safety Physical at home: paper or cardboard cannot be used in this instance to help students learn how to use a MIG welder Physical shop: students need to have access to a physical shop either at the school or in the community to learn how to use a MIG welder and practice with one to develop competency

Table 3.
Application of the hybrid learning design framework in TE based on Zitter and Hoeve (2012)

6. Conclusion

> In a time of drastic change, it is the learners who inherit the future. The learned usually find themselves equipped to live in a world that no longer exists. (Hoffer, 1973, p. 22)

In the coming months, the world will slowly begin to return to a "new normal", and communities will come to life. Teachers will return to school, with students following soon thereafter. With the governments' response to the pandemic came the creation of lists of "essential services" – those daily services that are essential to preserving life, health, public safety and societal functioning (GOBC, 2020). Among these essential services are health care, law enforcement, public safety and first responders, along with critical infrastructure, transportation, industry and manufacturing; the latter, fields which require engineering and trades skills that secondary students can *only* explore formally in TE. This research has

illustrated that, although TE teachers faced many challenges with ERT, the pandemic also revealed significant opportunities for schooling and none more so than demonstrating that TE is "essential" in the education of the next generation. Along with renewed pandemic-transformed pedagogical approaches that incorporate blended learning and more personal and individualized instruction, one of the many lessons learned as a result of the COVID-19 pandemic is that a reset of our education system is long overdue.

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