

## **Education 4.0. infusion into asynchronous teaching during a pandemic: A mixed-methods study of in-service TVET teachers in a Caribbean higher education context**

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**Abstract:** The fourth industrial revolution or Industry 4.0. and its resulting shift to Education 4.0. (Ed. 4.0) coupled with the COVID-19 global pandemic catalyzed the education system into emergency remote teaching (ERT). As a teacher educator, the author created an Ed. 4.0. Webquest learning activity for her in-service TVET teachers for modelling asynchronous teaching during the global pandemic. They were required to create a group webquest and infuse Education 4.0. critical characteristics for teaching asynchronously, in response to parents' calls for more asynchronous sessions in the interest of students' wellbeing during COVID-19 pandemic. These critical Education 4.0. characteristics include innovation and creativity; digital skills development; and global citizenship. The purpose of this case study is to describe the Ed. 4.0. characteristics TVET teachers infused into their Webquests in a Caribbean higher education context and their perceived readiness for Education 4.0. A Convergent Parallel Mixed Methods design was used for gaining a deeper understanding of the central phenomenon of infusion of Ed. 4.0. into TVET and feelings of readiness for ED. 4.0. The study results revealed that teachers infused all eight Ed. 4.0. characteristics into planned asynchronous teaching. However, only 5 (33%) out of the 15 (100%) teachers felt some level of readiness for Ed. 4.0. In conclusion, the study results suggest that more emphasis is needed on professional development for teachers' readiness for Ed. 4.0. The study implications signal that TVET teachers are preparing their secondary school students for life and work in an era of Industry 4.0. and a pandemic.

**Keywords:** Asynchronous teaching, Convergent parallel design, Ed. 4.0, Industry 4.0, TVET

### **1. Introduction**

The shift to Education 4.0. (Ed. 4.0) resulting from the Fourth Industrial Revolution or Industry 4.0. increased momentum as the Corona Virus Disease 2019 (COVID-19) forced the closure of schools and universities, catalyzing education systems into emergency remote teaching (ERT). The latter measure was necessary to

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curb the spread of this infectious deadly disease that was declared a global pandemic by the World Health Organisation on March 11, 2020, taking the lives of over 130, 000, 000 people worldwide (World Health Organisation, 2021). Unlike online learning that is planned and purposefully executed as long-term online delivery, ERT is a temporary measure that provides students with access to instruction for continuing their education in a virtual mode during a crisis such as a pandemic (Hodges, Moore, Lockee, Trust & Bond, 2020).

Educators worldwide had a contracted time to move their courses to a virtual mode and some doing so for the first time that required requisite training and resources to support this shift. In an effort to ensure students' continued learning, especially where resources were limited, the Microsoft Corporation partnered with United Nations International Emergency Fund (UNICEF) and launched the global Learning Passport platform to reach the over 1.57 billion students and their teachers in over 190 countries worldwide affected by closure of schools during the pandemic (UNICEF, 2020). In addition, the Chinese Ministry of Education's experience of accomplishing uninterrupted learning during the pandemic was compiled into a handbook entitled, *Handbook on Facilitating Flexible Learning During Educational Disruption: The Chinese Experience in Maintaining Undisrupted Learning in COVID-19 Outbreak*. This handbook was made available to teachers worldwide as a resource for teaching in a virtual mode during the pandemic in a collaborative effort between UNESCO and the authors (Huang, Liu, Tlili, Yang, Wang et al., 2020).

The researcher, as a teacher educator, facilitates capacity-building technology integration (TI) sessions for in-service teachers (includes TVET) at a School of Education (SOE) in a Caribbean higher education context. The TVET teachers enrolled in this one-year Post-Graduate Diploma Programme (Dip. Ed.), among others in different content areas, are at the secondary school level. Their training includes preparation for the delivery of the Caribbean Vocational Qualifications (CVQs) using competency-based assessment. They are expected to apply their TI skills in key assignments for successfully completing their programme such as in an action research project, e-Portfolio, and teaching field practicum (The UWI, October, 2020). The author received feedback from her in-service teachers that parents were calling for more asynchronous sessions in the interest of students' well-being due to them experiencing screen fatigue in ERT during the pandemic lockdowns at home. This fatigue from continuous exposure to the computer screen during virtual sessions has been identified, among others, as a factor affecting students' well-being, particularly their eye health, during the pandemic (Guo et al., 2021; Jaggars, 2021; Means & Neisler, 2021). Specifically, in a TVET Caribbean context, inhibitors affecting the online delivery during the pandemic include lack of know-how and training in the use of distance learning (DL) technologies and limited research on the design and delivery of TVET in a DL mode (Ndahi, 2020). Similar issues in teaching remotely during the pandemic were highlighted in research done in developed countries such as in the U.S., Germany, and Brazil (Jaggars, 2021). The current study responds to some of these issues raised in the literature in describing the Ed. 4.0. characteristics TVET in-service teachers infused into planned Webquests for asynchronous teaching and learning during the COVID-19 global pandemic.

The student teachers (secondary level), with over ten years of teaching experience and digital skills gained from their TI sessions, were required to create their own group Webquests over a three-week period and infuse at least 4 of the Education 4.0. critical characteristics as well as provide feedback on their group members' feelings of readiness for Education 4.0. They were provided with tutorial support by their assigned tutors coupled with a customized Moodle learning management course platform (MyeLearning) equipped with tools for all course communication and uploading/downloading of course materials for their Webquest TI sessions (The UWI, 2020). In addition, an alternative website to MyeLearning, with all course materials, was made available for students who experienced delays in registering on time and unable to access the MyeLearning platform at the commencement of the Dip. Ed. Programme (Dip. Ed., 2020). The purpose of this study is to describe the Education 4.0. characteristics in-service teachers infused into their Webquests, mostly in a TVET context, for distilling their readiness for Education 4.0. by answering the following overarching and sub-questions:

What are the Ed. 4.0. characteristics TVET teachers infused into planned Webquests for asynchronous teaching during a pandemic and their feelings of readiness for Ed. 4.0?

- ✓ What are the Ed. 4.0. characteristics in-service teachers, to include mostly TVET, infused into planned Webquests for teaching asynchronously during a pandemic?
- ✓ What are in-service teachers' feelings of readiness for Ed. 4.0.?

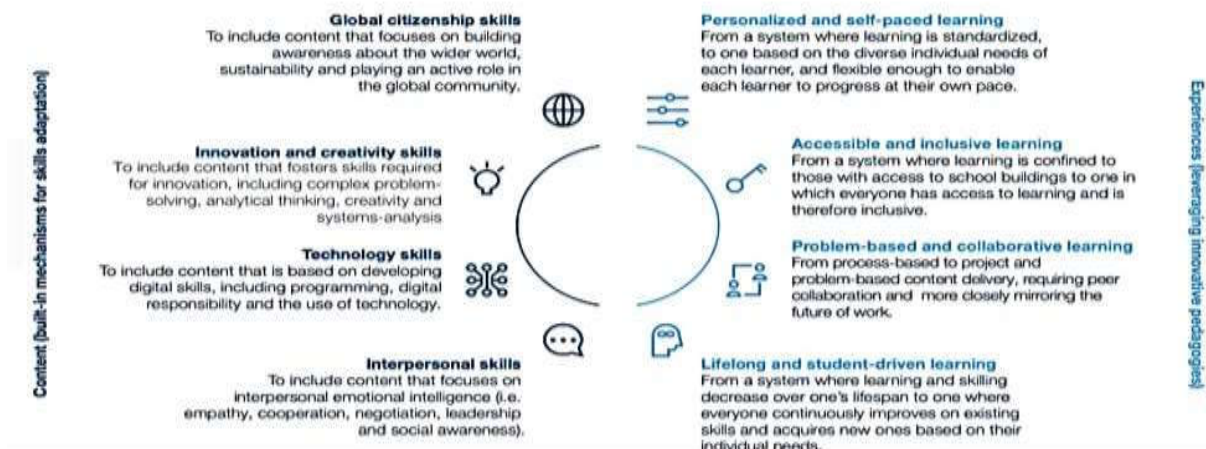
## **2. Literature review**

Mainly characterized by digital transformation in its trajectory, Industry 4.0. (IR4) builds on its predecessors, IR 1.0., 2.0., and 3.0. The first Industrial Revolution (IR1.0) around the 1780's was driven by water and steam power, causing disruption in loss of manual jobs due to increased mechanical production, but creating new jobs that improved the quality of life such as mass transportation via railroads as noted by Oliver (2020) and Salmon (2019). Contextually, vocational education was done through apprenticeships (i.e., work-based curriculum) during the 1800's outside of the formal school curriculum (Ferdinand, 2009). The second Industrial Revolution (IR2.0) in the 1900's was powered by electricity, enabling mass production prompting division of labour on production lines (Hussin & Bahasa, 2018; Oliver, 2020). The apprenticeship model declined in favour of mass production that led to education of masses in standardized skills to meet industry needs, while levelling the playing field for TVET. By progression, Education 1.0. emerged and branded, regrettably, as "transmission" in the teaching and learning process (Hussin & Bahasa, 2018; Salmon, 2019).

The dawning of the third Industrial Revolution (IR3.0) from the 1950's onwards into Industry 4.0. is powered by automation with the advancements in digital technology, allowing for faster and smarter production. This digital revolution included Web 1.0. (*read only web*) implemented in 1989 and accessed via the Internet. By 2004, Web 2.0. (*read and write web*) subsequently followed bringing a shift to Education 2.0. that offered more connectivity, collaboration, and interaction among teachers and students (Choudhury, 2014; Hafiz & Mahizer, 2019; Oliver, 2020; Salmon, 2019). The inevitable progression to Education 3.0. and Web 3.0. (*semantic web*) by 2006 brought a more ubiquitous experience, where learning occurred anywhere and at any time via mobile devices (e.g., smart phones and laptops) with Wi-Fi connectivity (Choudhury, 2014; Hafiz & Mahizer; Salmon, 2019). According to Hussin and Bahasa (2018), the rapid advancement from IR3.0. to IR4.0 has no historical precedent, thus being disruptive and "... blurs the lines between the physical, digital and biological worlds..." (p. 92).

Industry 4.0 and its resulting Education 4.0. enabled by Web 4.0. (*symbiotic web*) now challenge educators in preparing students for working in a digital economy where a symbiotic relationship between human and artificial intelligence coupled with digitized customer services and BIG DATA are becoming common place. The cyber-physical systems pervading the industrial sector, mostly in developed countries, signal the need for educating and training the future workforce in high-end skills as machines now perform the low-end skills (Salmon, 2019; Umachandran, Jurcic, Della Corte & Ferdinand-James, 2019). For example, packers are no longer needed on the assembly lines as robots perform this function. In reporting on the future of work in a digital economy, RMIT University, Europe (2020) included the following perspective from an industry partner: "A digitally-skilled workforce was foreseen in the Industry 4.0 roadmap – but the pandemic has accelerated the urgency to establish these skills at scale" (p. 4). Indeed, the COVID-19 pandemic provided a window into this digital economy in having to do business, work, teach, and learn remotely from home due to lockdowns for stemming the spread of the virus. This disruptive digital transformation prompted by Industry 4.0. also ushered in standards for digital intelligence (DQ), which is defined as "... a comprehensive set of digital competencies rooted in universal moral values for individuals to use, control, and create technology to advance humanity" (Yuhyun, 2019, p. 5). The DQ competencies cover a wide range to include job readiness, digital citizenship, and digital resilience and are of paramount importance in education, especially at the primary and secondary levels, in providing guidance and support for students exposed to cyber risks in their "new normal" digital world (Tedneke, (2017). In advancing the realization of Industry 4.0.

and its resulting Ed. 4.0., World Economic Forum (2020) provided a global Ed. 4.0. framework consisting of eight critical characteristics as shown in Figure 1.

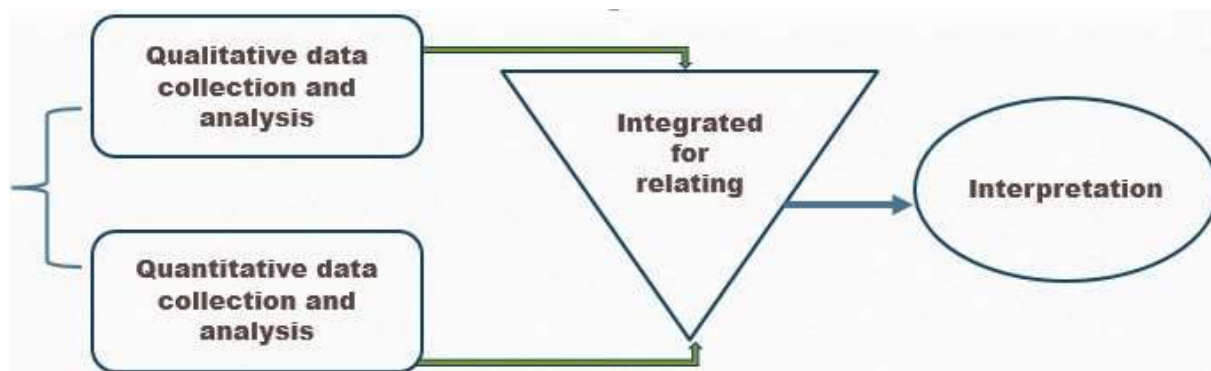


**Figure 1:** The World Economic Forum Education 4.0. Framework (World Economic Forum, 2020).

The choice of a Webquest by the author was used as it is an established asynchronous tool used by teachers at all levels of the education system for over two decades to include TVET that is referred to as Career and Technical Education in the U.S. (Internet4Classrooms, 2014). The Zunal.com free website was used for hosting the Ed. 4.0. Webquest (first of its kind at the writing of this paper with over 3,700 views (Ferdinand-James, 2021) as it is safe, secure, and provides self-explanatory digital templates in keeping with good instructional design comprising five key components: *Introduction, Task, Process, Evaluation, and Conclusion* (Internet4Classrooms, 2014). Webquests reflect the constructivist approach that is learner-centered and allows for collaborative learning and engagement informed by theories for learning in a digital age - constructivism, connectivism, and engagement (Jones, 2015; Marshall, 2007). The website only requires Internet access and a registered account on the Zunal.com website with all work securely stored on the website and easily accessible to students via the Internet. The latter makes it easy for teachers and students to access and use immediately, especially in making the transition to ERT. Research by the International Labour Organisation indicated that in some developing countries, such as in the Caribbean, lack of training in DL, Internet connectivity, and research on the design and delivery of TVET in a DL mode were challenges faced in the digitalization of TVET during the pandemic (Ndali, 2020; International Labour Office, 2021). Experts also contended that asynchronous sessions were well suited and met the needs of non-traditional mature students (St. Armour, 2020), who work and study like the TVET teachers, especially during the COVID-19 pandemic.

### 3. Methodology

A Convergent Parallel Mixed Methods design (see Figure 2) is used in studying the central phenomenon of Ed. 4.0. infusion for gaining a deeper understanding (DeCuir-Gunby & Schutz, 2017) of mostly TVET teachers' readiness feelings for ED. 4.0. and its infused characteristics into their webquests for asynchronous ERT. The pragmatic worldview guided the study design as it is problem- and practice-centered in orientation among other foci (Creswell, 2014). Hence, it is suitable for studying real-life issues TVET teachers experience in practice. Both qualitative (Webquests) and quantitative data (readiness for Ed. 4.0.) were collected concurrently, analyzed separately, and the results converged for an overall deeper interpretation and strengthening of the study findings, mitigating for weaknesses in using only qualitative or quantitative data.



**Figure 2:** Convergent Parallel Mixed Methods Design

The document analysis used for the study's qualitative data (Webquests) was guided by the Ed. 4.0. framework for interpreting and gaining an understanding (Bowen, 2009) of the Ed. 4.0. characteristics in-service teachers infused into planned asynchronous webquests for their secondary school students. Frequency percentages from in-service teachers on their Ed. 4.0. readiness feelings were tallied in analysing the quantitative data. Sampling of the population of 206 teachers was purposive, consisting of 11 out of the total 15 TVET student teachers in the Dip. Ed. Programme. Four of the TVET in-service teachers did not participate in the Webquest learning activity due to heavy workloads at their schools. Another group of four (4) social studies teachers who completed their webquest that was skills-based was included in the study, giving a total of 15 in-service teachers. They all gave permission for use of their webquest data in this research and were chosen as their groups completed the Webquest learning activity that were skills-based in the nature of TVET.

#### 4. Result and discussion

*Research Question 1.* What are the Ed. 4.0. characteristics in-service teachers, to include mostly TVET, infused into planned Webquests for teaching asynchronously during a pandemic?

The document analysis of the in-service teachers' webquests showed that they infused aspects of all eight critical characteristics of the Ed. 4.0. framework (see Figure 1). The Zunal.com website was slow in loading when the over 200 students tried to visit the free website. Consequently, students were given the option of using the "Word" template for the Webquest. Two groups used the latter, while the other two used the Zunal.com for creating their webquest websites. These Ed. 4.0. infused characteristics are described in the following sub-sections with supporting quotes from the teachers' webquests.

##### 4.1. Global citizenship

This Ed. 4.0. characteristic builds students' awareness about the wider world in actively engaging them in activities that contribute to global community sustainability (World Economic Forum, 2020). Teachers' webquests raised students' awareness on issues of sustainable tourism, recycling, food security, and sanitation, which are all affecting the global community in the current COVID-19 global pandemic. The following quotes from their webquests' task and conclusion descriptions are examples of how they planned to actively engaging students in these issues:

The Ministry of Tourism is on a drive to promote 'Sustainable Tourism Development ...'

You are tasked with creating an exciting 'weekend itinerary' for a group of first-time visitors

to the island ... [and] create a show stopping presentation to wow the judges at the Ministry of Tourism... (McLeod, Asson, Bharat & Marquis, 2021: 1)

... you're much brighter and knowledgeable on Plastic Pollution, Recycling and of course

creating a Container Planter [,] which is a great solution to reducing your Carbon footprint ... (Appoo & Budhai, 2021, Section, Conclusion)

#### **4.2. Innovation and creativity**

This Ed. 4.0. characteristic helps to develop students' innovative and creative skills in engaging them in activities that require thinking creatively and analytically as well as solve complex problems (World Economic Forum, 2020). Teachers planned for developing these skills in students by requiring them to do the following in their Webquests: create a local weekend tour for first-time visitors to Trinidad and Tobago; re-use plastic containers for planting food; and engage in innovative experiential learning both as an individual and in groups. The following quotes from their webquests' introductory descriptions are examples of how teachers planned to actively engaging students by infusing this Ed. 4.0 characteristic:

As an incentive to local Travel Agencies, the Ministry of Tourism is hosting a 'Weekend Tour Competition', and the winning travel agency will be rewarded with \$5000.00 to support their business! You are tasked with creating an exciting 'weekend itinerary' for a group of first-time visitors to the island. (McLeod, Asson, Bharat & Marquis, 2021: 1)

This is my problem: I went outside to see if I can plant my own vegetables but I have no space. I live in a concrete jungle so I have no soft earth to dig into to plant my seeds. What can I do? (Appoo & Budhai, 2021, Section, Introduction)

#### **4.3. Technology skills**

This Ed. 4.0. characteristic requires teachers to develop students' digital skills to include using different technology tools and exercising digital responsibility (World Economic Forum, 2020). Teachers planned for developing these skills in students by requiring them to do the following in their Webquests: create an eye-catching presentation for a local weekend tour for first-time visitors to Trinidad and Tobago; use a "Word" version of the online Webquest template for presenting their Webquests on re-using plastic containers for planting food; capture the process of making a nutritious soup on camera and include in an e-Portfolio; and engage in innovative experiential learning both as an individual and in groups. The following quotes from their webquests' introductory and process descriptions are examples of how teachers planned to actively engaging students by infusing this Ed. 4.0 characteristic:

Create an eye-catching and upbeat presentation, using Google Slides, to convince the judges of the following: A. Why is your tour itinerary the most attractive to tourists? B. How can your tour offerings promote and sustain tourism development in Trinidad and Tobago? (McLeod, Asson, Bharat & Marquis, 2021: 2)

Students will view the demonstration video on preparing a Homemade Chicken Noodle Soup... Students will take pictures during each stage of the process and of the final product as evidence of the work done to be placed in their portfolios. (Webquest, n.d.a, Section: Process).

#### **4.4. Interpersonal skills**

This Ed. 4.0. characteristic helps to develop students' interpersonal skills by engaging them in learning activities that require them to empathize, cooperate, negotiate, lead, and be socially aware in working with others (World Economic Forum, 2020). Teachers planned for developing these skills in students by requiring them to do the following in their Webquests: foster empathy in creating a meal for someone not feeling well; cooperate in creating a weekend island tour; manage a Crop Investigative Project; and communicate effectively in preparing a group research assignment. The following quotes from their webquests'

introductory and process descriptions are examples of how teachers planned to actively engaging students by infusing this Ed. 4.0 characteristic:

When you have completed the worksheet the group leader must SHARE the document with the other group leaders... Group leaders you are to ensure that your peers in your group are able to access the shared documents... Now that you all have networked and collaborated you are to write a short summary of EVERYTHING you learnt from your peers. (Appoo & Budhai, 2021, Section, Process)

Niece#2 is not feeling well, does not have much of an appetite, and would like something to restore her energy... Niece#3 just ran through the rain and is feeling cold and would like something to warm her up. (Webquest, n.d.a, Section: Introduction).

#### **4.5. Personal and self-paced learning**

This Ed. 4.0. characteristic helps with self-pacing for learners in meeting their individual needs instead of standardized learning for all students (World Economic Forum, 2020). Teachers planned for such flexibility in learning by using a small-group approach that allow for self-pacing of group members and individual tasks in their Webquest learning activities. The following quotes from their webquests' task and process descriptions are examples of how teachers planned to actively engaging students by infusing this Ed. 4.0 characteristic:

Complete these tasks for the six (6) week period of the Crop Investigative Report:

1. Gather tools and materials needed for data collection (data recording sheet, ruler, paper, pen/pencil).
  2. Record the leaf number and plant survival for each pakchoi plant in the grow boxes ...
- (Webquest, n.d.b, Section: Collecting Data for Crop Production SBA)

After you have watched the link download the attached worksheet according to the link your group was assigned... Once downloaded you are to fill in your names and each of you must answer the questions being asked as it relates to the video you watched. (Appoo & Budhai, 2021, Section, Process).

#### **4.6. Accessible and inclusive learning**

This Ed. 4.0. characteristic advocates for all students having access to learning whether in F2F or virtual classrooms, making learning truly inclusive (World Economic Forum, 2020). Teachers' webquests accommodated for such access by using the Zunal.com website freely accessible on the Internet or use the "Word" version of this template. One webquest required students to be present on the school compound for their investigative crop project. However, the latter was not quite in keeping with the asynchronous requirement for the webquest learning activity in which students were to work off the school compound and in keeping with COVID-19 lockdown protocols. The term "inclusive" was not specifically used in teachers' webquests. The following quotes from their webquests' task and conclusion descriptions are examples of how they planned to actively engaging students in infusing this Ed. 4.0. characteristic:

Working in a group of 4: 1. Research various tourism sites in Trinidad and Tobago. You can use websites. (McLeod, Asson, Bharat & Marquis, 2021: 2)

Hi Students, you are to work in groups to search and view the following links posted below ... Students when you click on links (according to your group of course), you will receive a wealth of knowledge on various topics all linked to the main topic of Container Planting. (Appoo & Budhai, 2021, Section, Task).

#### **4.7. Problem-based and collaborative learning**

This Ed. 4.0. characteristic requires content and learning activities that are problem-based and promote collaboration amongst students, reflecting a real-world context towards work in the future (World Economic Forum, 2020). Teachers planned for such problem-based and collaborative learning by having students work on various group projects to address problems of sustainable tourism development, recycling, food security and sanitation that are impacting many countries during the COVID-19 global pandemic. The following quotes from their webquests' introductory and task descriptions are examples of how teachers planned to actively engaging students by infusing this Ed. 4.0 characteristic:

You are a co-owner of a Travel Agency in Trinidad and Tobago. The Ministry of Tourism is on a drive to promote 'Sustainable Tourism Development' ... Design a tour itinerary for a group of tourists that promotes the tourism sector of Trinidad and Tobago. Demonstrate competency in using 'Google Docs' and 'Google Slides' for collaboration and oral presentation.

(McLeod, Asson, Bharat & Marquis, 2021: 1)

This is my problem: I went outside to see if I can plant my own vegetables but I have no space. I live in a concrete jungle so I have no soft earth to dig into to plant my seeds. What can I do? (Appoo & Budhai, 2021, Section, Introduction).

#### **4.8. Lifelong and student-driven learning**

According to the widely cited World Economic Forum (2020) framework, this Ed. 4.0. characteristic requires moving from a "system where learning and skilling decrease over one's lifespan to one where everyone continuously improves on existing skills and acquires new ones based on their individual needs" (p. 4). Teachers planned for lifelong and student-driven learning by highlighting the benefits of the skills students learnt like growing their own food, developing sustainable tourism, and practicing food sanitation. However, the term "Lifelong" was not specifically used in their webquests. Students were also given student-centered tasks as the Webquest is an asynchronous tool that requires a constructivist approach to learning. The following quotes from their webquests' task and conclusion descriptions are examples of how teachers planned to actively engaging students by infusing this Ed. 4.0 characteristic:

1. First you are required to divide yourselves into groups of 4 students. 2. In your groups view the PowerPoint and take notes in your notebooks. 3. In your groups students will discuss the characteristics of a well-prepared soup. (Webquest, n.d.a, Section, Introduction)

... plastics harm the environment and recycling and reusing them can not only help the environment but you can practice sustainable agriculture too and even make some money by planting crops at home...Win-Win for everyone. (Appoo & Budhai, 2021, Section, Conclusion)

*Research Question 2. What are in-service teachers' feelings of readiness for Ed. 4.0.?*

Teachers were asked to rate their feelings of readiness for Ed. 4.0. as follows: very ready, ready, somewhat ready, and not ready. As shown in Figure 3, a total of 5 out of the 15 teachers indicated their readiness feelings for Ed. 4.0. This finding suggests that most teachers need more time and professional development to feel ready for Ed. 4.0. The Ed. 4.0. characteristics infused into their Webquests also confirm the latter, as the terms "inclusiveness" and "lifelong learning" were not included in descriptions of their Webquests. Integrating both the quantitative and qualitative data analysis here helps to strengthen and better understand the study results.

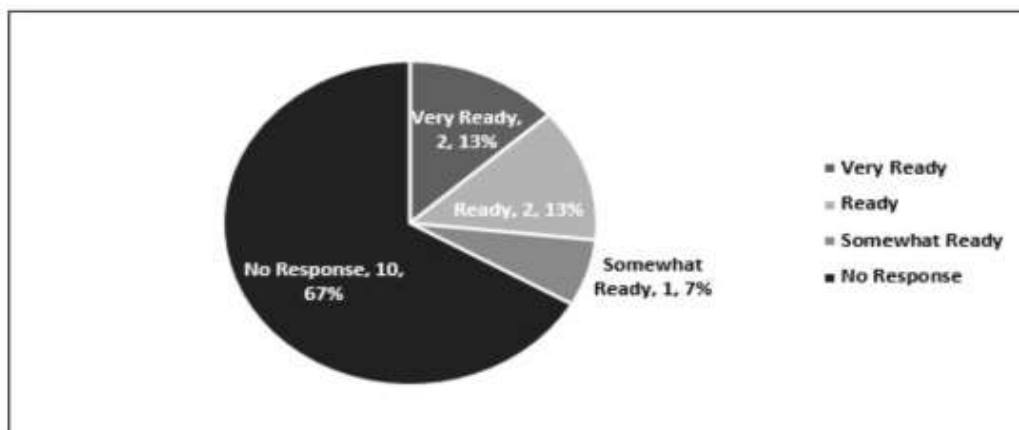


Figure 3: Teachers' Feelings of Readiness for Education 4.0. (N=15)

### 5. Conclusion

The purpose of this study is to describe the Education 4.0. characteristics in-service post-graduate students infused into their Webquests, mostly in a TVET context, for distilling their readiness for Education 4.0. The study findings reveal that teachers' infused aspects of all eight critical characteristics of Education 4.0. into their Webquests. This infusion is in keeping with the constructivist approach to teaching that affords learner-centeredness and active collaboration among learners informed by theories for learning in a digital age - constructivism, connectivism, and engagement (Jones, 2015; Marshall, 2007). This study finding answers the clarion call in the literature for educational institutions to prepare students for a digitally-skilled workforce in responding to Industry 4.0. and its resulting Ed. 4.0. global framework (Hafiz & Mahizer, 2019; Hussin & Bahasa, 2018; RMIT University, Europe, 2020; World Economic Forum, 2020, January). This response is even more critical for TVET that serves as a skills pipeline to industry and helps to close the "perennial" gap highlighted in the literature between educational institutions and industry (Hafiz & Mahizer, 2019; Oliver, 2020; Salmon, 2019; World Economic Forum, 2020 January). In addition, teaching remotely during the pandemic brought several challenges on a global scale to include both student and teacher fatigue from continuous hours of screen time (Gillett-Swan, 2017; Jaggars, 2021; Thurston et al., 2021). The in-service teachers enrolled in the Post-Graduate Dip. Ed programme were able to develop an asynchronous strategy of using a Webquest as part of their TI sessions for addressing the key challenge of screen fatigue. Moreover, their Webquest designs employed the constructivist approach to learning that allows for student-centeredness, engagement, collaboration, and connectedness as described in theories of learning in a digital age (Jones, 2015). The asynchronous approach to learning during pandemic is in keeping with calls from noted experts for such an approach as it caters to students' needs for more flexibility in meeting work, study, schooling, and family commitments (St. Amour, 2020).

Contextually, research by the International Labour Organization in 11 Caribbean countries reported several shortfalls in the delivery of TVET during the pandemic such as lack of know-how and training in the use of distance learning (DL) technologies and limited research on the design and delivery of TVET in a DL mode. TVET teachers in this study were trained and facilitated, during the pandemic, using distance learning (DL) platforms and strategies, making them better prepared for TVET delivery in a DL mode. However, none of the TVET teachers responded to the repeated calls for describing the feelings of readiness for Ed. 4.0., which may signal a need for such reinforcement in their professional development for the next cohort in the Dip. Ed. Programme. The integration of the quantitative and qualitative data analysis help to better understand the findings in this study, which also helps to narrow the stated gap in the literature for the latter research. In addition, the practical applications of teachers' Webquests for asynchronous teaching are publicly available on the free Zunal.com website for other TVET teachers and curriculum developers to access in their practice

towards Ed. 4.0. as done with the handbook on the Chinese experience uninterrupted delivery of education during the pandemic (Huang, Liu, Tlili, Yang, Wang et al., 2020; Ferdinand-James, 2021; Webquest, n.d.a; Webquest, n.d.b). The Zunal.com website is safe and secure for both teachers and students in responding to security alerts raised in the Digital Intelligence Global standards (Yuhyun, 2019).

While not generalizable to the entire population of teachers (206) in the Dip. Ed programme and other educational contexts due to the small sample size (15 in-service teachers), the implications of the study findings can be beneficial in moving forward. These in-service TVET teachers and students are better prepared to avoid screen fatigue among their students during the pandemic, enhancing the virtual teaching-learning process that can potentially redound to successful learning outcomes. Also, the infusion of the Ed. 4.0. characteristics into their Webquests will also better prepare students for working in a digital economy, making them more marketable especially in a TVET context. However, programme coordinators and TVET teacher educators would need to place more emphasis on infusing ED. 4.0. characteristics, especially for lifelong learning and inclusiveness, in their teaching practice component to boost TVET teachers' feelings of readiness for Ed. 4.0. This research also provides an opportunity for replication by other researchers using a randomized larger sample in institutions at different levels (e.g. community colleges and universities) so that the study results can be generalized.

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