JTET

http://penerbit.uthm.edu.my/ojs/index.php/jtet
ISSN 2229-8932 e-ISSN 2600-7932

Journal of Technical Education and Training

Contemporary Employability Skills Needed for Learners to Succeed in the Civil Technology Field in the 4IR Era

Thokozani Isaac Mtshali[1*], Manto Sylvia Ramaligela[2]

[1,2]Department of Mathematics, Science and Technology Education,
University of Limpopo, Polokwane-Sovenga, 0727, SOUTH AFRICA

*Corresponding Author

DOI: https://doi.org/10.30880/jtet.2020.12.03.003
Received 15th May 2020; Accepted 14th July 2020; Available online 30th September 2020

Abstract: The contribution of Civil Technology to the Fourth Industrial Revolution (4IR) is largely dependent on whether learners can acquire the necessary knowledge and skills that will make them employable in this field. The 4IR is characterised by rapid technological advances which are changing the face of many industry sectors. Competition is at an all-time high and the need to keep pace with technological shifts has never been so great. Not surprisingly, Civil Technology teachers have a crucial role to play in ensuring that learners are able to confidently make the transition from the classroom to the world of work. In this regard, teachers must have the ability to stimulate learners' interest and nurture their talents in one or more Civil Technology specialisation/s, but they themselves must have sufficient knowledge and skills if they are to be effective educators. The purpose of the study was to explore what contemporary employability skills are needed for learners to ultimately succeed in the Civil Technology field in the 4IR era. An explanatory sequential mixed-method approach was followed, using both quantitative and qualitative research methods. A key finding was that although Civil Technology teachers are well aware of the importance of remaining responsive to industry needs in the 4IR era, they faced many personal and administrative challenges when it came to actually developing the necessary skills among their learners. Teachers also displayed a general lack of awareness of the value that Civil Technology could deliver to companies, entrepreneurs and the economy as a whole. The study lifted the lid on an important, but until now neglected, area of research which warrants more in-depth investigations, particularly how to bring teachers up to speed in a fast-changing environment.

Keywords: Civil technology, employability skills, hands-on skills, 4IR

1. Introduction

Unemployment has become a chronic problem in developing countries (Mukhoti, 2019). Such countries are witnessing an increase in their rates of unemployment, both among those who have lost their jobs due to retrenchment and those who have never been employed. The general consensus seems to be that rising unemployment is directly attributable to the fact that skills are not responsive to global trends. The world is witnessing the unfolding of the Fourth Industrial Revolution (4IR), which seems to be deepening social inequality between First and Third World countries (Jerome & Ajakaiye, 2019). Economic survival means that the upskilling and reskilling of individuals need to take centre stage. Accordingly, a strategic approach to skills development is crucial.

Identifying which employability skills are responsive to 4IR has never been so important. This is a global imperative (Loy & Novak, 2019). Similarly, the need for South Africa to develop clear policies and approaches to 4IR has never been so great, particularly when it comes to the country's Technical Education (TE) curriculum. The South African government has identified 13 trades and selected 26 training institutions that are being targeted to provide skilling, reskilling and upskilling of individuals in designated trades to ensure that South Africa is not left behind as 4IR gains momentum. This means that schools offering technical subjects must support 4IR-responsive trades.

*Corresponding author:thokozani.mtshali@ul.ac.za/ thokozanimtshali63@yahoo.com

Technical schools play a crucial role in equipping learners with hands-on skills that ensure employability, productivity and competitiveness in the global economy (Turner, 2016; Dasmani, 2011). Teachers from such schools are therefore required to have a sound knowledge of different industries and practical industry experience. Armed with this knowledge, these teachers will know which employability skills industries need and will ensure that their teaching approach prepares learners for the reality of work (Tcherneva, 2018). In this day and age, industries are increasingly incorporating robotics, artificial intelligence, energy capture, geoengineering, and virtual and augmented reality (among other innovations) into their operations. Educational institutions must keep pace with these developments.

The subject Civil Technology has an important role to play in making 4IR a reality, although not much has been documented about it. In essence, the value of Civil Technology to 4IR is dependent on how successfully it can build employability skills. Hence, the main aim of Civil Technology is to ensure that learners are in a position to "demonstrate understanding of the industry, enhance knowledge, skills, values and reasoning abilities as well as establishing connections to life outside the classroom and address real-world challenges" (DBE/PAT, 2018:29). Against this background, it seems fair to say that Civil Technology has a duty to respond to industries' needs, many of which revolve around 4IR. Civil Technology teachers, in turn, must develop contemporary skills that are responsive to the 4IR era. Thus this study explore the following questions:

RQ1: Which contemporary employability skills do Civil Technology teachers teach that are 4IR-responsive?

RQ2: Which employability skills are necessary for Civil Technology to be 4IR-responsive?

2. Conceptual framework

This study was adapted to the concept of "employability skills" as developed by the Australian Learning and Teaching Council (2011) and Zaharim et al. (2009). The concept of employability skills grew out of the need to capacitate individuals with knowledge and skills relevant for job attainment and maintenance and promotional purposes (Zaharim et al., 2009). Such skills fall into three categories: generic skills, core skills and personal attributes (Australian Learning and Teaching Council, 2011). Ismail and Mohammed (2015) view these skills as having particular relevance for the Technical and Vocational Education and Training (TVET) curriculum in South Africa. Moreover, in terms of this study, the classification of employability skills helps in the identification of those Civil Technology skills that are responsive to 4IR.

2.1 Generic Skills

Generic skills are sets of non-technical skills, such as "problem-solving skills", that ensure the employability of individuals. They are concerned with people using their logical imagination to find solutions to current problems and to prevent future ones (Sproull, 2018). The skill of "adaptability", in turn, is concerned with the flexibility to perform multiple jobs in an organisation (Chan, Ahmad, Zaman & Ko, 2018). The skill of "professionalism" is concerned with the ability to communicate well with all stakeholders and role players in an organisation, at all levels.

"Lifelong learning" is a skill that is not practised enough in organisations and is therefore very valuable when it is in evidence. It is associated with individuals who want to sharpen their knowledge and improve their craft for their own and their organisation's benefit (Sproull, 2018). The "teamwork skill" or "mediator skill" is concerned with the ability to work holistically with team members and engage in group problem-solving (Hoffart et al., 2017).

"Information and communication technology skills" (sometimes referred to as "computer skills") are considered to be the most relevant for 4IR. They are concerned with understanding the digital world. The "initiative and enterprise skill" is concerned with finding better ways of doing things in order to produce more or be more effective. For example, initiative and enterprise skills are particularly important in the 4IR era in the face of all the changes that are taking place in how people live, work and communicate.

2.2 Core Skills

Core skills are sets of technical skills, such as "knowledge of technology education principles", that ensure the employability of individuals (Zaharim et al., 2009). Core skills relate to the application of basic scientific principles (Moore, 2013). Employers often prefer people with knowledge of how to improve structures in the physical world and make them more aesthetic. "Knowledge of contemporary issues" relates to knowing what clients want. Ongoing research helps people to develop this skill. "Competency in the Civil Technology education discipline" relates to understanding different specialisations in the subject, such as civil services, construction and woodworking (Mtshali, Ramaligela & Makgato, 2018).

2.3 Personal Attributes

Personal attributes are positive attitudes and traits that make people employable in different circumstances (Zaharim et al., 2009). They help individuals to understand people's behaviour and to tolerate them in the best interests of an organisation. Understanding how different people interact with each other plays a big role in production and marketing.

For instance, it is important to know different languages because learners are taught how to use machines, materials and equipment from different countries.

4. Methodology

This study used a sequential, explanatory mixed-method approach (Creswell, 2013). This study used both qualitative and quantitative research. This study adopted a qualitative approach because it allowed the researcher to combine descriptions of events, people and behaviours (Ramaligela, Mji & Ogbonnaya, 2015). The quantitative approach, in turn, was seen as ideal because it involved exploring contemporary employability skills, which are 4IR-responsive, that Civil Technology teachers develop through their lessons**.** This was advantageous as it allowed a large number of teachers to express their opinions openly without losing interest in the study (Creswell, 2013).

4.1 Participants and The Study Context

The target population for the study comprised school teachers, subject advisors and academic experts in Civil Technology in South Africa. A convenient sample of 57 Civil Technology teachers from all nine provinces was chosen, mainly those who attended the annual Technical Teachers Conference in 2018 and 2019. Targeting these teachers allowed for a wide range of views to be canvassed.

4.2 Data-collection Instruments

The study selected questionnaire and interviews as data collection instruments. The questionnaire was aimed at identifying the contemporary, 4IR-responsive employability skills that Civil Technology teachers set out to develop in their learners. According to Zohrabi (2013), the main advantages of a questionnaire are that participants are able to express their attitudes, feelings and beliefs about a topic in a short space of time, which allows more issues to be covered. The study used Bless and Higson-Smith (2000) Likert scale with 1 for Agree, 2 for Disagree and 3 for Not sure. A structured interview approach was also used to probe what employability skills in the field of Civil Technology are necessary to ensure alignment to 4IR. According to Teddlie and Tashakkori (2009), interviews provide the opportunity for enquirers to ask for explanations and collect powerful, meaningful data. Hence, this study found it useful.

4.3 Data-collection Procedure

A questionnaire was carefully designed according to the purpose of the study. The questionnaire soft-copies were firstly made available to participants via emails and later on conference commissions session's hard copies prior to the Technical Conference. This was to allow participants ample time to familiarise themselves with them and to comment on their contents. The various questions were presented on overhead projector slides. With the help of the session chair, hand counts were done to determine the number of responses to each question, with the categories being Agree, Disagree and Not sure. Where there was miscounting or the numbers did not tally with the responses, a re-run of questions was performed. For all questions, administered results were made instantly available to all participants and confirmed as offering a true reflection.

The interview procedure was a little different in the sense that the researcher conducted interviews after the parallel sessions were concluded. Not all participants were available for interviews. However, those who were left in the session for further discussions became participants in the interviews. The researcher was aware that interviewing all participants would increase the amount of data, providing richer responses. One-on-one interviews were conducted with each of the six teachers using the same questions as those in the questionnaires, but the focus was on: "Which contemporary employability skills are necessary for 4IR?" All data-collection procedures were explained to the participants who indicated that they were comfortable with their views being recorded on a notepad, provided they remained anonymous.

4.4 Data Analysis

Data collected through the questionnaire were presented and analysed statistically. Responses were represented numerically both as whole numbers and as percentages for reader-friendly interpretation. MS Excel spreadsheet software was used to analyse the quantitative data. Tables were created showing each item in the questionnaire and the input was thereafter analysed statistically. In order to legitimise the data and enhance the credibility of the study, the researcher ensured the validity, reliability and trustworthiness of the data-collection instruments.

The validity of the questionnaire instrument in this study was ensured by using a peer reviewer who was provided with valuable input on the kind of questions to be asked (Creswell, 2013). The researcher took advice from Lincoln and Guba (1985) who suggest that the peer reviewing of instruments is crucial because it allows questions to be constructively scrutinised by asking in-depth questions about the methods used and the interpretation of the answers. The study also used experts in the field to map out a way forward and add clarity to the questions in order to enhance the validity of the questionnaire. The researcher used and adapted the Bless and Higson-Smith (2000) Likert scale format to ensure that the questionnaire instrument measured what it was supposed to measure. This scale ensured the reliability of the instrument. Credibility was assured by sending the research findings back to the participants to ensure that they were an accurate

representation of their inputs (Bryman & Bell, 2007). The interview participants confirmed that the interpretations arrived at reflected their views.

The interview data were analysed on their respective merits, given that the participants had a different opinion to say during the interviews. Hence, the researcher transcribed the data from the individual face-to-face interviews which had been obtained during the data collection stage of the study. The researcher read and sorted the responses from the teachers. During this process, statements projecting similar ideas were grouped together. This was done by reading all the transcripts and taking note of major statements, quotes, words or key concepts. Subsequently, the researcher coded significant statements or descriptors of individual experiences into units such that each code corresponded with a distinctive, non-repetitive statement that had equal significance.

The study provided interviewees with an opportunity to respond to the questions in detail, resulting in in-depth, descriptive accounts of the phenomenon under investigation. This supported transferability (Bryman & Bell, 2007). To ensure conformability, the researcher exercised objectivity when interpreting and analysing the data collected during the interviews. The researcher did not permit his personal views and values to influence the conduct of the research or the results (Bryman & Bell, 2007). All interviews conducted with participants were written up in a notepad. The researcher was aware that using a tape recorder would make it easier to record things later in writing. However, scribbling was seen as appropriate as participants could see what was written on their behalf. Only the researcher and the peer reviewer have access to the participants' data. The data, which are in hard-copy format, will be kept in a safe at the University of Limpopo for up to five years.

5. Results and Discussion

A total of 57 respondents were involved in this study. A total of 43 respondents (75.44%) were male and 14 respondents (24.56%) were female. In relation to teaching experience for Civil Technology subject, 8 respondents (14.03%) had 1 to 5 years' experience, 27 respondents (47.37%) had 6 to 10 years' experience, 19 respondents (33.33%) had 11 up to 15 years and three respondents (5.27%) had over 16 years of experience. For the professional qualification item, 55 respondents (96.49%) had a Bachelor of Education degree, while two respondents (3.51%) had Diplomas in Education plus certificates in Civil Engineering certificates. Those two respondents were from the category of 16 years and above of teaching experience. Respectively, respondent's demographic information is shown in Table 1.

Table 1 - Respondent's demographic information.

Demography Aspects	Frequency	Percentage (%)
Gender		
Male	43	75.44
Female	14	24.56
Teaching experience (Civil Technology)		
1-5 years	8	14.03
6-10 years	27	47.37
11-16 years	19	33.33
16 and beyond	3	5.27
Professional qualification		
Diploma	2	3.51
Bachelor Degree	55	96.49

5.1 Contemporary Employability Skills for Civil Technology Teachers

The Australian Learning and Teaching Council (2011) was used to present employability skills categories. Consequently, the total number of responses to each question varied since some of the participants had left the conference room or were discussing other matters with colleagues when the questions were administered. For the generic skills, nine concerns were explored. Those concerns are presented in Table 2 below.

5.1.1 Generic Skills Theme

Table 2 - The generic skills with which teachers aim to equip their learners.

	Concerns	Agree	Disagree	Not sure	Total number of responses
1.	Do you equip your learners with problem-solving skills?	57 (100%)	-	-	57 (100%)
2.	Do you equip your learners with skills that will make them easily adaptive to the work environment? (Adaptability)	56 (98.25%)	-	1 (1.75%)	57 (100%)
3.	Do you think the content coverage makes your learners more marketable in big industries? (Adaptability)	18 (31.58%)	26 (45.61%)	13 (22.81%)	57 (100%)
4.	Are Civil Technology learners sufficiently well prepared to conduct themselves and communicate professionally in an industrial environment? (Professionalism)	34 (60.71%)	-	22 (39.29%)	56 (100%)
5.	Is there a need for Civil Technology learners to continue with their studies beyond matric?	56 (100%)	-	-	56 (100%)
6.	Would you prefer that your learners receive external training (TVET colleges or universities) before having industry exposure?	15 (28.85%)	29 (55.77%)	8 (15.38%)	52 (100%)
7.	Do you provide your learners with an opportunity to work in teams during practical lessons?	54 (94.74%)	1 (1.75%)	2 (3.51%)	57 (100%)
8.	Do you teach your learners information and communication technology (ICT) skills to prepare them for the digital world?	9 (16.36%)	46 (83.64%)	-	55 (100%)
9.	Do you equip your learners with initiative and enterprise skills, particularly during practical lessons?	15 (26.31%)	6 (10.53%)	36 (63.16%)	57 (100%)

One of the most crucial skills in Civil Technology is problem-solving skills where learners are expected to find solutions for technological problems. Learners would be given case scenarios relating to the built environment and a systematic technological process is used to solve problems. As such, it is not surprising that Under Concern # 1, All 57 teachers (100%) responded in the affirmative of equipping learners with problem-solving skills. This result suggests that Civil Technology teachers are well aware that learners need hands-on, practical skills to solve technological problems. This is supported by Kirlbrink and Bjurulf (2012) who assert that any technical education subject is traditionally underpinned by an apprenticeship system, which means that craftsmanship, vocational trades and other skills domains all require problem-solving.

In the same footing, attention should be drawn from the results of concerns number 3, 6 and 7. About 45.61% of teachers disagreed to that Civil Technology's content coverage give learners a marketing advantage in the eyes of big industries. This is equally disturbing as it raises a concern to whether are learners equipped with responsive industrial knowledge and skills or otherwise. This finding, however, mirrors the findings of Makgato (2011) that most technology education teachers still struggle to impart the skills needed to ensure that learners are employable once they complete school. Sadly, this conflicts with the aim of Civil Technology that, once they have completed this subject, learners will have a more significant advantage in the engineering field.

On the other hand, Concern # 6, gives a reason why 56 teachers responded that learners might still need to receive more training after schooling completion for the reason that the content they received at school does not give them the industrial advantage. It is a norm for teachers to encourage their learners to become lifelong learners (Robinson, Neergaard, Tanggaard & Krueger, 2016). Thus, according to the CAPS (Curriculum and Assessment Policy Statement), Civil Technology aims to develop the skills levels of learners to the extent that they will be able to join a career pathway at college or university immediately after obtaining their matric (DBE, 2011). Another skill considered essential for industrial access is the ability to work with others (teamwork). According to Lazareva and Kovtun (2018), one of the advantages of teamwork is that many other skills are enhanced, which is what the field of Civil Technology encourages. Consequently, 54 teachers (or 94.74%) agreed that they provided learners with the opportunity to develop teamwork skills.

Nevertheless, Concern # 2 reveal that 98.25% of teachers agreed to be equipping their learners with skills that would make them easily adaptive to the work environment. These results are consistent with a statement made by the DBE/PAT (2018) that Civil Technology learners should be able to demonstrate an understanding of the industry and to establish

connections to life outside the classroom and address real-world challenges. This echoes with views by Smith and Tyler (2011) that teachers have a tendency to create a work-based environment when teaching practical lessons.

The lack of understanding the impact of ICT in Civil Technology as reported by Mtshali and Ramaligela (2020) was also tested in this task. About 83.64% of this teachers indicated to not preparing their learners with information and communication technology (ICT) skills. This finding correlates with claims made by Mtshali, Ramaligela and Makgato (2019) that most Civil Technology teachers do not use digital resources to enhance learning. For concern #9, about 63.16% of teachers were not sure to be equipping learners with initiative and enterprise skills. This result correlates with the view of Cook (2011) that part of the problem is that technical education primarily focuses on professional knowledge and hands-on skills, while entrepreneurial knowledge is ignored. In this regard, Nwambam, Nnennaya and Nwankpu (2018) propose that technical education needs to capacitate learners with entrepreneurial skills, while teachers need to be retrained so that they are competent to provide entrepreneurship education.

5.1.2 Core Skills Theme

Table 3 - The core skills with which teachers aim to equip their learners.

	Concerns	Agree	Disagree	Not sure	Total number of responses
1.	Do you teach and encourage your learners to be creative and innovative when they do practical lessons? (Knowledge of technology education principles)	51 (89.48%)	6 (10.52%)	-	57 (100%)
2.	Do you equip your learners with knowledge that allows them to hone their contemporary skills?	4 (7.55%)	49 (92.45%)	-	53 (100%)
3.	Are you constantly equipping your learners with skills that integrate all three specialisations in Civil Technology? (Competency in Civil Technology education discipline)	44 (83.01%)	8 (15.09%)	1 (1.89%)	53(100%)

Creativity and innovativeness are central to respond to 4IR, in fact it is was industries want from upcoming employees and partners. Accordingly, fifty-one teachers (or 89.48%) agreed to encourage learners to be creative and innovative in preparation for the industrial world. This result indicates improvements from that of (Dempsey,2013) that most teachers still face challenges when trying to create an environment that allows learners to be creative and innovative, as is required in the 21st century. Indeed this era requires high levels of creativity and innovativeness (Mtshali & Ramaligela, 2020). Sadly, when establishing if they equipped their learners with knowledge that allowed them to hone their contemporary skills. Only 53 teachers responded to the question. Of these, four teachers (or 7.55%) agreed and 49 (or 92.45%) disagreed. This result indicates that there is still a lot to be done by teachers to prepare learners to display contemporary skills which are needed by various industries.

Teachers were asked to determine if they constantly equipped their learners with skills that integrated all three specialisations in Civil Technology. Only 53 teachers responded to this question. Of these, 44 teachers (or 83.01%) agreed. Civil Technology, by nature, integrates theoretical content knowledge as a basis for practical skills. In theory lessons, learners are equipped with content knowledge and knowledge of design processes, which are then used to build practical skills. According to Mtshali, Ramaligela and Makgato (2018), content knowledge in Civil Technology subjects includes: civil services, construction and woodworking. These authors, therefore, concur with the study's results.

5.1.3 Personal attributes theme

Table 4 - The results of the personal attributes with which teachers aim to equip their learners.

	Concern	Agree	Disagree	Not sure	Total number of responses
1.	Do you ensure that your learners become acquainted with the industrial environment through your teaching?	27 (50.94%)	13 (24.53%)	13 (24.53%)	53 (100%)
2.	Do you emphasise to your learners the importance of understanding the needs of clients, which necessitates hands-on service?	11 (20.75%)	42 (79.25%)	-	53 (100%)

Table 4 - (Continue)

Concern	Agree	Disagree	Not sure	Total number of responses
Do you encourage your learners to find out how to respond to different societal behaviours when rendering their hands-on service?	2 (3.77%)	51 (96.23%)	-	53 (100%)

When determining if teachers ensured that their learners became acquainted with the industrial environment through their teaching. Only 53 teachers responded to this question. Of these, 27 teachers (or 50.94%) agreed which contradicted with Mwaokolo (2003) view that the training that learners receive in their workshops at school is quite different from that encountered in industry. Hence, this has an impact on job opportunities. In determining whether teachers emphasise the importance of understanding the needs of clients, which required hands-on service, about 79.25% of them disagreed. This was a testimony to the fact that there are many issues that still need to be explored in technical education, particularly when it comes to instructional practice (Dempsey, 2013). According to Oviawe, Uwameiye and Uddin (2017), one of the most challenging aspects of technical education is that most of its activities do not address the urgent needs of clients. Hence, 96.23% disagreed to be encouraging their learners to find out how to respond to different societal behaviours when rendering their hands-on service.

5.2 Necessary Employability for Civil Technology

The purpose of this section was to seek clarity from practising Civil Technology teachers on which employability skills they deemed were necessary for the 4IR environment. The researcher read and then sorted the responses from the Civil Technology teachers. In sorting the responses, the researcher grouped together all statements conveying similar inputs. For example, a statement like, "... *all PAT scenarios we received from DBE require that learners solve problems*..." would be grouped together with a statement like "... *I give them lots of tasks that require problem-solving*...." Hence, all interview responses were presented:

Interview questions on the generic skills theme were 3; the first looked at the kind of problem-solving skills that teachers think learners should be equipped with in this era. Currently, the Department of Basic Education (DBE) assists teachers in equipping learners with problem-solving skills by administering a number of hands-on, practical tasks. Given that these tasks are standardised nationally, they are not helping to solve contextual technological problems. They are, therefore forcing learners to learn skills that may not help them in the long run. This view is supported by Autio, Soobik, Thorsteinsson and Olafsson (2015) who assert that learners need to solve contextual technological problems, thereby cutting the cost associated with skills exports in various communities. Pertaining the question under scrutiny, this is how the teachers responded:

Teacher A: I think we should get back to our old PAT designs, where learners get a scenario of the technological problems that need to be solved instead of giving a PAT that requires artefact-making only.

Teachers C, D & E: We must move away from theory; it does not give jobs. Our learners need to solve problems that are contextual to their living environment. Not all these communities need 4IR technologies, but instead we need to renovate our RDP houses, repair potholes and fix burnt schools. Civil Technology should solve such problems in South Africa.

These teachers indicate the need to contextualise problem case scenarios in order to teach learners skills that they can use in their everyday life. Therefore, a problem-solving approach is needed to address realistic tasks. On the issue of the Civil Technology content do teachers think should be improved to better prepare learners for future employment. The content of Civil Technology is arranged in a way that when one topic content is not well taught, it will affect how learners will understand the upcoming topics. However, this subject also emphasise more on ability to use drawing as part of communication skill, to which is an important skill to attain employment in the engineering space. Nonetheless, most teachers found it too challenging to respond to this question. However, Teacher C responded in the following way:

Teacher C: Graphics and communication should be improved by teaching these using computer-aided drawing because most people are building houses now and they need beautiful plans. So this will assist in self-employment amongst these learners.

Teacher C's response resonated with the view of Reuschke (2016) that one of the emerging businesses at present is the redesign of homes and the conversion of part of the structure into a rental accommodation. This was creating self-employment. The third issue on this theme looked at how ICT skills can be infused into Civil Technology to prepare learners for the digital world. This is how teachers responded:

Teachers A, B, D, E & F (unanimous view): Civil Technology does not require ICT skills; it is all about building and repairing. As long as you have consumables and working machinery in a workshop, that means all

is well. You must remember that ICT skills are soft skills, and so for us we always wear overalls, meaning that we deal with hard-labour skills. So there is no need to infuse ICT into either Civil or Mechanical Technology.

Teacher C: I personally use a laptop when I teach. In my workshop I do not have enough tools, so when I teach about tools and how they are used, I take my learners to the I-Centre in the school so we can watch video clips on how certain tools are used in real life.

There are many benefits to using ICT skills in the built environment. According to Wang et al. (2018) ICT have the ability to improve efficiency and cut the use of goods, thereby reducing economic demands. The consensus view evident in these teachers' responses seems to be that no ICT skills can be infused into Civil Technology. Even though Teacher C indicated that she used a laptop as a prop to teach, she could not show how these ICT skills could be infused into the learning content, other than to use a computer as a knowledge-transmission tool. It would seem that Teacher C was aware that video usage was generally high among learners with adequate internet bandwidth (Puspita & Rohedi, 2018). This implies that an increasing number of young people are using videos to access information, primarily on YouTube (Hutchinson, 2017).

However, these teachers' views reflect the assertion by Cohen and Katz (2015) that most technical education teachers fail to teach skills that meet industry's needs. This means that they struggle to create contemporary teaching environments. The results are particularly worrying given that we are now living in a digital era which is increasingly impacting the education space. For example, digital technologies are gradually being used as vehicles to deliver educational knowledge and skills in new and innovative ways (Grand-Clement, 2017).

Interview questions on the core skills theme were also 3. The first looked at how teachers teach and encourage learners to be creative and innovative when they do their practical artefacts. Most teachers indicated that it was almost impossible to be creative and innovative in any of their practical activities.

Teacher D: I do not even think about that because …. look, we have other classes with big numbers that we have to teach … I do not only teach Civil Technology in my school, so I do not have time to check on how learners beautify their artefacts …. as long as they followed the instruction, then I am fine.

Teacher E: The way we do PAT now …. learners do not do even have a file where they can be creative … so it is not us who fail to encourage creativity and innovativeness but it is the PAT document that has all those limitations.

These views resonate with those of Nyerere (2018) who asserts that teachers in technical education are now so overwhelmed by administrative work that it is difficult for them to focus on hands-on skills that are pertinent to society as a whole. The second issue was to find out how teachers equip learners with knowledge that allows them to hone their contemporary skills. All teachers were unable to respond to this question, which indicates that most teachers do not know how to assist learners with contemporary skills that meet the demands of 4IR. Currently, factors such as structural design, construction site management and cost of construction are regarded as major influencers of the Civil Engineering curriculum (Hughes, Champion & Murdoch, 2015). Yet it seems that most Civil Technology teachers are not aware of that. The last part was to explore if teachers constantly equip learners with skills that integrate all three specialisations in Civil Technology. Most teachers indicated that even though the Department (meaning the DBE) had separated specialisations, their content delivery was still closely integrated. This view was in line with the assertion by Mtshali, Ramaligela and Makgato (2018) that the subject Civil Technology is an amalgamation of three specialisations, namely, construction, civil services and woodwork.

Interview questions on the personal attributes theme were 2. The first question focused on how teachers ensure that learners are acquainted with the industrial environment. According to Cropley (2016) engineering students lack practical skills. The reason behind the lack of practical skills amongst graduates is that TVET institutions do not make efforts to train learners with transferable and soft skills that industries recommend (Lawson, Fallshaw, Papadopoulos, Taylor & Zanko, 2011). Thus, it important to constantly understand if there are any developments in this regard. So teachers were asked and this is how they responded:

Teacher D: I normally use local industries as examples of whatever concepts I am teaching about … where I refer learners to industries they know about so that they better understand what I am talking about.

Teacher E: By just stressing that they wear protective clothing before they start with the practical … it means I have acquainted them with the industrial environment.

Most teachers indicated that they used well-known industries as benchmarks when giving examples to their learners. The last question on this theme was to find out how teachers teach learners about the importance of understanding clients' needs when providing a hands-on service. The foregoing discussion about the unresponsiveness of TVET institutions to industrial needs implies that there is a great misconnection between these stakeholders (Mashongoane, 2015). As such, the courses developed in these institutions to give skills to learners are to be continuously reviewed. In fact, according to Mutereko and Wedekind (2016) most of the leaners are found incompetent to perform skills required by industries. As

such, their ability to understand the clientele of the built environment has to be questioned. All teachers indicated that they had a challenge in this regard. However:

Teacher D: It is difficult to say because we do not even sell any artefact to anyone at school, so I personally do not do it.

It is for this reason that Nwambam, Nnennaya and Nwankpu (2018) advised that technical institutions need to equip learners with entrepreneurial skills and also retrain teachers to become competent to teach entrepreneurship. The advent of 4IR has unleashed many new perspectives in education, such that teachers are expected to prepare their learners for a totally unknown world and for jobs that are not yet in existence (Romiszowski, 2016). Employability skills should be pivotal in this process.

This study has provided useful insights into contemporary employability skills that Civil Technology teachers should impart which are responsive to the 4IR era. The study has also established that teachers of Civil Technology often face challenges when identifying and teaching certain employability skills that are associated with the 4IR era. For instance on the question of contemporary employability skills that Civil Technology teachers teach that are 4IR-responsive, this study found that, according to the Australian Learning and Teaching Council (2011) employability skills themes, Civil Technology teachers faced challenges with respect to generic skills, core skills and personal attributes. In terms of generic skills, the challenge was in equipping learners with adaptability skills, ICT skills, and initiative and enterprise skills. This was a sign that most Civil Technology learners still lack social and personal resource skills which complement technical skills and are necessary for strong performance under 4IR (Flin & O'Connor, 2017). In terms of core skills, Civil Technology teachers faced a challenge in equipping their learners with knowledge of technology education principles and contemporary skills. Similar results were recorded by Mtshali (2020), who noted that most Civil Technology teachers lack the competence to ensure that their learners' complete school with the necessary hands-on skills. Stronge (2007), in turn, views Civil Technology teachers as lacking in the qualities that make them effective educators. In terms of personal attributes, Civil Technology teachers faced a challenge in equipping learners with the ability to understand the needs of clients and to render hands-on services that were in tune with different societal behaviours.

On the question of employability skills that are necessary for Civil Technology and 4IR-responsive, Civil Technology teachers deemed all employability skills necessary to meet the demands of the 4IR era. However, they indicated that they faced a challenge in equipping learners with core and personal attributes. This study revealed that Civil Technology teachers had only a limited understanding of how Civil Technology can be of benefit in the 4IR era. This is because they perceived 4IR as requiring soft skills only; they did not see Civil Technology as a hands-on subject. In fact, this is the general perception in many developing countries where there are no clear policies guiding the education sector in how to create a sustainable learning environment that successfully leverages the technological advances of the 4IR era.

6. Conclusion and Recommendations

This study has gone some way towards enhancing our understanding of how a sustainable learning environment can be created for Civil Technology so that teachers can take advantage of the technological advances associated with 4IR. Although the teachers reported that they had limited knowledge of how to equip learners for 4IR in the field of Civil Technology, the study nevertheless provided valuable insights into the matter. In particular, it showed how the development of learners' employability skills should be the primary function and focus of Civil Technology teachers as, without such skills, learners are likely to be left behind and their prospects of securing positions in fast-changing industries will be poor.

In conclusion, this study showed that most Civil Technology teachers have a challenging time equipping their learners with contemporary employability skills which are responsive to the demands of the 4IR era. Therefore, more emphasis should be given to adapting teaching methods and learning programmes to ensure that learners are better prepared for the ongoing developments taking place in different industry sectors. ICT skills are becoming increasingly important when communicating with clients, while entrepreneurial skills help learners to establish and run their own businesses, thereby contributing to the economy and creating a wider and more sustainable talent pool. Furthermore, teachers themselves should undergo upskilling via continuous professional development. Taking these steps will help to minimise the likelihood of there being deficiencies in the contemporary skills arena and large cohorts of learners not finding suitable or any work (Zaharim et al., 2009).

Recent changes to the structure of the Civil Technology PAT have added to the challenges faced by teachers in helping learners acquire employability skills in the 4IR era. In this regard, a key recommendation flowing from this study is that teachers should put more intense effort into the development of core skills and personal attributes so that they can prepare their learners for the unknown. In a quest to improve employability skills in Civil Technology which are in tune with 4IR advances, in-service teachers and those already in full-time positions should be made aware of these skills and their importance to the economy. The DBE, and the Departments of Higher Education and Training and Science and Technology should be urgently called upon to promote such awareness via their many communication channels and professional networks.

The 4IR era has arrived; there is no turning back or ignoring the rapid unfolding of events. The education sector needs to enthusiastically catch the wave if it wishes to remain relevant today and in the future. Further and more in-depth studies are needed on the various themes covered in this paper, i.e. the skills required for proficiency and long-term relevance in the Civil Technology industry and how the teaching profession can keep up to date with the demands of the 4IR.

Acknowledgement

The authors would like to thank all the TVET institutions of Limpopo province, the SASOL Inzalo Foundation and the Department of Research Administration and Development in the University of Limpopo for supporting this research project.

References

Afeti, G. (2018). Revitalising technical and vocational education and training in Africa: Issues outstanding. *Journal of Vocational, Adult and Continuing Education and Training*, *1*(1), xi–xi.

Australian Learning and Teaching Council. (2011). Graduate Employability Indicators: Introduction and User Guide. Canberra: Australian Learning and Teaching Council.

Autio, O., Soobik, M., Thorsteinsson, G., & Olafsson, B. (2015). The development of craft and technology education curriculums and students' attitudes towards technology in Finland, Estonia and Iceland. *International Journal of Contemporary Educational Research*, *2*(1), 22–34.

Bless, C. & Higson-Smith, C. (2000). *Fundamentals of Social Research Methods: An African Perspective.* (3rd. ed.). Lansdowne: Juta Education.

Bryman, A. & Bell, E. (2007). *Business Research Methods*. New York: Oxford University Press.

Chan, S. W., Ahmad, M. F., Zaman, I., & Ko, W. S. (2018). Employers' perception on important employability skills in the manufacturing industry. *International Journal of Engineering & Technology*, *7*(2.29), 170-175.

Cohen, K. & Katz, R. (2015). Teaching mechanical design practice in academia. Faculty of Mechanical Engineering, Technion, Haifa 32000, Israel.

Cook, V. S. (2011). *Entrepreneurship Education at a FET College* (Doctoral dissertation, Nelson Mandela Metropolitan University).

Creswell, J. W. (2013). *Qualitative Inquiry and Research Design: Choosing Among Five Traditions* (3rd ed.).Thousand Oaks, CA: Sage Publications.

Dasmani, A. (2011). Challenges facing technical institute graduates in practical skills acquistion in the upper east region of Ghana. Regional Education Directorate, Ghana.

De Miranda, M. A. (2012). Pedagogical Content Knowledge and Engineering and Technology Teacher Education: Issues for thought. *Journal of the Japanese Society of Technology Education, 50*(1), 17–26.

Dempsey, M. (2013).Impacts of the Changing Nature of the Vocational Education and Training (VET) System on Educators within the VET System in Australia. Thesis Doctor of Education, School of Education Faculty of Education and Arts Edith Cowan University.

Department of Basic Education (2011). *Curriculum assessment policy statements (CAPS): Civil technology.* Available from download. South Africa: Pretoria.

Department of Basic Education. (2019). Civil Technology PATs. Available from: https://www.education.gov.za/Portals/0/Documents/PATS2019/Civil%20Technology%20PAT%20GR%2012%202019%20Eng.pdf?ver=2018-11-30-082312-000

Flin, R. & O'Connor, P. (2017). *Safety at the sharp end: A guide to non-technical skills*. CRC Press.

Fraenkel, J. R. & Wallen, N. E. (2003). *How to design and evaluate research in education*. New York: McGraw-Hill.

Grand-Clement, S. (2017). Digital Learning: Education and Skills in the Digital Age. Santa Monica, CA: RAND Corporation and Corsham Institute.

Hoffart, G., Gibbard, K., O'Neill, T., Nygren, A., & Rosehart, W. (2017). Assessing and developing the individual and team work attribute. *Proceedings of the Canadian Engineering Education Association (CEEA)*.

Hughes, W., Champion, R., & Murdoch, J. (2015). *Construction contracts: Law and management*. New York; Routledge.

Hutchinson, A. (2017). Mind-Blowing YouTube Stats, Facts and Figures for 2017 (Infographic).

Ismail, S. & Mohammed, D.S. (2015). Employability Skills in TVET Curriculum in Nigeria Federal Universities of Technology. 4th World Congress on Technical and Vocational Education and Training (WoCTVET), 5th–6th November 2014, Malaysia.

Jerome, A. & Ajakaiye, O. (2019). Reviving Industrialization in Africa. In *African Economic Development* (pp. 425–448). Emerald Publishing Limited.

Jilcha, K., Kitaw, D., & Beshah, B. (2016). Workplace innovation influence on occupational safety and health. *African Journal of Science, Technology, Innovation and Development*, *8*(1), 33–42.

Kirlbrink, N. & Bjurulf, V. (2012). Transfer of knowledge in technical vocational education: A narrative study in Swedish upper secondary school. *International Journal for Technology and Design Education*, *23*(3), 519–535. Springer: Science Business Media.

Lawson, R., Fallshaw, E., Papadopoulos, T., Taylor, T., & Zanko, M. (2011). Professional learning in the business curriculum: Engaging industry, academics and students. Asian Social Science, 7(4), 61-68.

Lazareva, O. Y., & Kovtun, O. O. (2018). *Synergy effect of teamwork in learning English* (Doctoral dissertation. : Kharkiv Polytechnic Institute: National Technical University.

Lincoln, Y. & Guba, E. G. (1985). Naturalistic Inquiry. Beverley Hills, California: Sage Publications, Inc.

Loy, J. & Novak, J. I. (2019). The Future of Product Design Education Industry 4.0. In *Redesigning Higher Education Initiatives for Industry 4.0* (pp. 164–182). IGI Global.

Makgato, M. (2011). Technological process skills for technological literacy: A case of few technology teachers at schools in Tshwane North District D3, South Africa. *World Transaction on Engineering and Technology Education*, *9*(2), 119–124.

Mashongoane, T. S. (2015). The impact of National Certificate Vocational on the continued learning: patterns and destination of the FET colleges engineering graduates in the North West Province (Doctoral dissertation).

Moore, D. F. (2013). *Principles and Applications of Tribology: Pergamon International Library of Science, Technology, Engineering and Social Studies: International Series in Materials Science and Technology* (Vol. 14). Elsevier.

Morse, J. M. (2016). *Mixed method design: Principles and procedures* (Vol. 4). New York: Routledge.

Mtshali, T. I. (2020). Critical thinking skills for Civil Technology practical assessment tasks (PATs). World Transactions on Engineering and Technology Education (WIETE) Vol.18, No.2. 237-241.

Mtshali, T. I., & Ramaligela, S. M. (2020). The Rhetoric of Hands-On Practical Skills: Advancement of Innovative Teaching and Learning Techniques in Civil Technology. In *Socio-Economic Perspectives on Vocational Skill Development: Emerging Research and Opportunities* (pp. 31-55). IGI Global.

Mtshali, T. I., Ramaligela, S. M., & Makgato, M. (2019). Usage of digital resources in Civil Technology: A case of teaching tools and equipment. *African Journal of Science, Technology, Innovation and Development*, 1–9.

Mtshali, T. I., Ramaligela, S. M., & Makgato, M. (2018). Challenges faced by Civil Technology teachers in preparing and presenting theory and practical lessons in South African schools: A case of five schools in the Ekurhuleni district. Magister in Education. Pretoria: Tshwane University of Technology.

Mukhoti, B. B. (2019). *Agriculture and employment in developing countries: Strategies for effective rural development*. Routledge.

Mutereko, S., & Wedekind, V. (2016). Work integrated learning for engineering qualifications: a spanner in the works. *Journal of Education and Work*, *29*(8), 902-921.

Mwaokolo, P. O. E. (2003). Related thoughts in vocational education. The development of world experiences. AWKA: Marpat Educational Research and Publishers.

Nwambam, A. S., Nnennaya, O. O., & Nwankpu, I. S. (2018). Evaluating the entrepreneurship education programme in Nigerian universities for sustainable development. *Journal of Entrepreneurship Education*, *21*(1), 1–13.

Nyerere, J. (2018). Youth Unemployment in Kenya: Incorporating Entrepreneurial and Transferable Skills in Education. *Youth Entrepreneurship and Africa's Sustainable Industrialization*, 125.

Oviawe, J. I., Uwameiye, R., & Uddin, P. S. (2017). Bridging Skills Gap to Meet Technical, Vocational Education and Training School-Workplace Collaboration in the 21st Century. *International Journal of Vocational Education and Training Research*, *3*(1), 7.

Puspita, R. H., & Rohedi, D. (2018, February). The Impact of Internet Use for Students. In *IOP Conference Series: Materials Science and Engineering* (Vol. 306, No. 1, p. 012106). IOP Publishing.

Ramaligela, S., Mji, A., & Ogbonnaya, U.I. (2015). *Effective preparation of mathematics and technology education pre-service teachers: A case of a university of technology in South Africa.* Doctor of Education. Pretoria: Tshwane University of Technology.

Reuschke, D. (2016). The importance of housing for self-employment. *Economic Geography*, *92*(4), 378–400.

Robinson, S., Neergaard, H., Tanggaard, L., & Krueger, N. F. (2016). New horizons in entrepreneurship education: From teacher-led to student-centred learning. *Education+Training*, *58*(7/8), 661–683.

Romiszowski, A. J. (2016). *Designing instructional systems: Decision making in course planning and curriculum design*. Routledge.

Schmidt, W. (2017). Future civil engineering challenges – skill requirements, new professional profiles and implementation.

Sibiya, A. T. & Nyembezi, N. (2018). Examining factors that shape Technical Vocational Education and Training engineering students' understanding of their career choices. *Transformation in Higher Education*, *3*, 6.

Smith, D. D. & Tyler, N. C. (2011). Effective inclusive education: Equipping education professionals with necessary skills and knowledge. *Prospects*, *41*(3), 323.

Sproull, B. (2018). *The Problem-solving, Problem-prevention, and Decision-making Guide: Organized and Systematic Roadmaps for Managers*. Taylor & Francis.

Stronge, J. H. (2007). *Qualities of effective teachers*. Alexandria: Association for Supervision and Curriculum Development (ASCD).

Tcherneva, P. R. (2018). The Job Guarantee: Design, Jobs, and Implementation.

Teddlie, C. & Tashakkori, A. (2009). *Foundations of mixed methods research*. Thousand Oaks, CA: Sage.

Turner, G. K. (2016). *Understanding Industry Experiences of Vocational High School Teachers Transferring Skills to Students: A Qualitative Phenomenological Study*. Northcentral University.

Wang, T., Xiao, F., Zhu, X., Huang, B., Wang, J., & Amirkhanian, S. (2018). Energy consumption and environmental impact of rubberized asphalt pavement. *Journal of Cleaner Production*, *180*, 139-158.

Wolf, S. (2017). Past meets present – The history of the German vocational education and training model as a reflection frame to the prospect of the Egyptian model. *Kaiser, F./Krugmann, S.(Hg.): Rostocker Schriften der Berufspädagogik*, *1*, 89–108

Zaharim, A., Yusoff, Y. M., Omar, M. Z., Mohammed, A., & Muhammad, N. (2009). Engineering employability skills required by employers in Asia. *Proceedings of the Asia 6th WSEAS, International Conference on Engineering Education Rodos, Greece, July 22–24, 2009,* pp. 195–201.

Zohrabi, M. (2013). Mixed Method Research: Instruments, Validity, Reliability and Reporting Findings. *Theory & practice in language studies*, *3*(2).