Jurnal Penelitian dan Pengkajian Ilmu Pendidikan: e-Saintika
https://journal-center.litpam.com/index.php/e-Saintika/index

March 2023 Vol. 7, No. 1
e-ISSN: 2615-6881
pp. 1-17

The Significance of Hand Tool Skills in the Fourth Industrial Revolution: A Focus on the Construction Concept

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Received: December 2022; Revised: January 2023; Published: March 2023

Abstract

The study investigated the significance of hand tool skills in the Fourth Industrial Revolution (4IR) era in teaching the construction concept in a civil Technology subject. The construction concept is one of the most practical concepts in civil Technology that is learnt in the Further Education and Training stream in the South African education curriculum. It deals with issues that cut across bricklaying and plumbing among others. Purposive sampling was used to select six teachers to take part in the study. Classroom observation and semi-structured interviews were used as instruments for data collection. The Technological Pedagogical and Content Knowledge framework was used to support the study. Data were analysed descriptively for classroom observations and through verbatim quotes for interviews with teachers. The study's findings discovered that teachers lack knowledge and understanding of 4IR and that they fail to use instructional practices that prepare learners for the 4IR jobs because of a lack of support from school officials. Teachers also lack the essential technologies to prepare learners that would thrive in the 4IR workplaces; hence their instructional practices are still using hand tools in the construction concept, which is not significant to the current trends. The study recommends that the Department of Education needs to train teachers to be ready to prepare learners for the 4IR jobs within the construction sector.

Keywords: Fourth Industrial Revolution; Hand tools; Construction; Technological Pedagogical Content Knowledge

How to Cite: Mhlongo, K. M., Khoza, S. D., & Skosana, N. M. (2023). The Significance of Hand Tool Skills in the Fourth Industrial Revolution: A Focus on the Construction Concept. *Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika*, *7*(1), 1–17. https://doi.org/10.36312/esaintika.v7i1.1026

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INTRODUCTION

Construction is one of the concepts learnt in civil technology which aims at enhancing the quality of life of an individual and society and ensures sustainable use of the natural environment (Mokhothu et al., 2015). Mokhothu et al. (2015) further adds that the concept of construction is often called Building construction in the Further Education and Training (FET) field in the Technical and Vocational Education and Training (TVET) sector. This is where learners are taught the basics and advanced skills of building, for the erection of structures that in layman's term is called houses. The construction industry is gradually changing due to the technological advancements that are happening globally, but many schools still find themselves using basic hand tools to teach learners. However, we are currently living in an era that is technologically driven, and as such, classroom instructional practices are vital

in moving on with the times. Therefore, the teacher's role is of utmost importance in the classroom in ensuring that technology is integrated into the classroom lesson delivery, for the sake of relevance in the industry. According to Agyei et al. (2022), teachers' competencies encompass knowledge, skills, and abilities that result in essential behaviors expected from them. Just like in Mathematics (Agyei et al., 2022), civil technology, which is a subject wherein construction is a concept, demands that its teachers possess adequate 'technical' knowledge, ICT skills, and self-efficacy beliefs to incorporate technology in their lesson delivery. This is so because, in a country that is troubled by the youth unemployment rate, South Africa needs skilled personnel that graduates from the school system that is aligned with the needs of the technologically driven industry.

Industries need production to compete globally and as such, they must go with the 'revolutions' that keep on emerging. The industrial revolution generally refers to periods in modern human history where technological innovation resulted in a drastic shift in the socioeconomic status of people (Schwab, 2016). In a study by Mhlanga and Moloi (2020), it is mentioned that the changes brought forth by the Fourth Industrial Revolution (4IR), the World Economic Forum (WEF) estimated that 65% of children entering primary schools will end up working in entirely new occupations or jobs that do not exist now. This then places the use of hand tools in concepts like construction in the spotlight because of their relevance. With the construction industry being one of the major sectors in job creation (Schwab, 2016), the continued use of hand tools in the sector is worrying and needs to be looked at as to why the use of hand tools is still in use, hence the study. With the 4IR being viewed as a threat to jobs as well as the ordinary way of doing things (Davis, 2020), it would have been great to see teachers occupying the space in integrating technology to bring their learners, through their instructional practices, closer to the industries that have since moved with the technological times. Schwab (2016) alluded to the fact that construction is an essential part that contributes largely to economic growth, many pieces of construction equipment have been introduced since the 1st industrial revolution that makes construction work easy, quick, and as well safe. This study then aimed at investigating the significance of hand tools in the Construction concept in an era that is dominated by the 4IR concept.

According to South Africa's policy document, the Curriculum and Assessment Policy Statement (CAPS), civil Technology aims at developing a high level of knowledge and skills in learners (Department of Basic Education, DoE, 2014). It (civil Technology) embraces practical skills and the application of scientific principles and aims to create and improve the built environment to enhance the quality of life of the individual and society alike and to ensure the sustainable use of the natural environment. However, the use of hand tools in the era of 4IR is not discussed as to how it would be addressed since most schools in the country still rely on hand tools for practical lessons. This then continues to make the learners' Practical Assessment Task (PAT), which is a practical assessment that weighs 30% of the entire module, being done using hand tools. In a study that was conducted in Ghana by Agyei et al, (2022), difficulties associated with using technology are not exclusively due to a lack of technological resources, but also due to an insufficient supply of trained human resources. This shows that perhaps teacher preparedness, skills, knowledge, and self-efficacy beliefs could be an issue in this regard hence this study.

According to the DoE (2014), any school offering practical subjects such as civil technology is mandatory to have a workshop with tools and equipment. However, it seems like teachers and school leaders are sceptical about acquiring the latter and opt for old ways which in this case are hand tools. According to Mtshali et al. (2020), working with tools and equipment develops manual labour skills which are in high demand in sub-Saharan countries to forge what has been designed into reality. This assertion means that the more learners are exposed to tools and equipment, the better the chances they find themselves in getting a decent job. This then puts a spotlight on teachers who are at the forefront of the learning experience to ensure that such opportunities for learners are made, by ensuring that their instructional practices are aligned with what is happening in industries.

The fourth industrial revolution (4IR) is a term coined by Klaus Schwab, founder, and executive chairman of the World Economic Forum, that describes a world where individuals move between digital domains and offline reality with the use of connected technology to enable and manage their lives (Miller, 2016). It is the current and developing environment in which disruptive technologies and trends such as the Internet of Things (IoT), robotics, Virtual Reality (VR), and Artificial Intelligence (AI) are changing the way we live and work (Xu et al., 2018). Much as these technologies are often seen as disruptive, in essence, they are what is needed now. This means that civil Technology construction teachers are inclusive of the suggestion made to prepare learners for the 4IR era by teaching construction learners about 4IR and using 4IR technologies so that the learners are employable in the future workplace. If civil Technology construction teachers are not preparing learners with 4IR skills, they (learners) would not benefit from the opportunities that would be presented by 4IR. According to Tcherneva (2018), teachers from technical schools are obligated to have a thorough knowledge of different trades and practical engineering experience, equipped with this knowledge, these teachers would know which employability skills industries need and would ensure that their teaching method prepares learners for the reality of work.

When ICT is not integrated into teaching, learners run the risk of being left behind from the 4IR practices. Shava and Hofisi (2017), recommend that the government needs to be ready to adapt to changes presented by the 4IR. This study also ascertained the schools' readiness as far as 4IR (ICT integration) has gone. In civil Technology, construction learners are taught equipment and tools in theory lessons, then taken to the workshop to do the practical. Their practical lesson includes learning how to lay bricks using hand tools such as a bricklaying trowel, spirit level, gauge rod, steel tape measure, line/corner blocks, steel pegs, and many more. Whereas on the other hand, 4IR presents robots that may lay bricks and erect houses more efficiently and effectively. Therefore, this study investigated the use of hand tools within a digitally driven workforce (industries) and ascertained the risks that civil Technology learners are facing in being prepared for jobs that are no longer in existence because of being swallowed by technology integration.

The study had the following objectives: (1) To investigate the significance of hand tool skills in the construction concept in the 4IR era; (2) to investigate the readiness of the civil Technology construction teachers for the 4IR; and (3) To get to see the civil Technology teachers' instructional practices in the construction concept. To get to the realisation of the above objectives, the study was grounded on the idea of the Technological Pedagogical Content Knowledge (TPACK) framework, as

simplified by Kim (2018). The TPACK framework was introduced to the educational research field as a theoretical framework for understanding teachers' knowledge required for effective technology integration (Kim, 2018). TPACK presents the three kinds of knowledge which are: technology, pedagogy, and content, which complement each other for the effective and optimal teaching and learning of the modern era (Abbitt, 2011). The TPACK framework builds on Shulman's construct of Pedagogical Content Knowledge (PCK) to include technology knowledge (Kim, 2018).

Teachers play a vital role in the teaching and learning process with the aim of preparing learners to be employable in the future. To do that, teachers need to master their subject content (what they teach) according to their area of specialisation. However, that is not enough because they (teachers) also need to be able to transfer the content knowledge to learners in an easy and understandable way. The rapid change and increase of technology development in the world force teachers to not only know the content and their teaching methodologies but also the technologies that must be integrated into teaching and learning processes, so that they prepare learners for the technology-driven world (Koehler et al., 2013). TPACK assists teachers to understand how to use technology to teach concepts in a way that augments learners' learning practices. The below figure illustrates the different forms of knowledge that form the model of the TPACK framework (Abbitt, 2011).

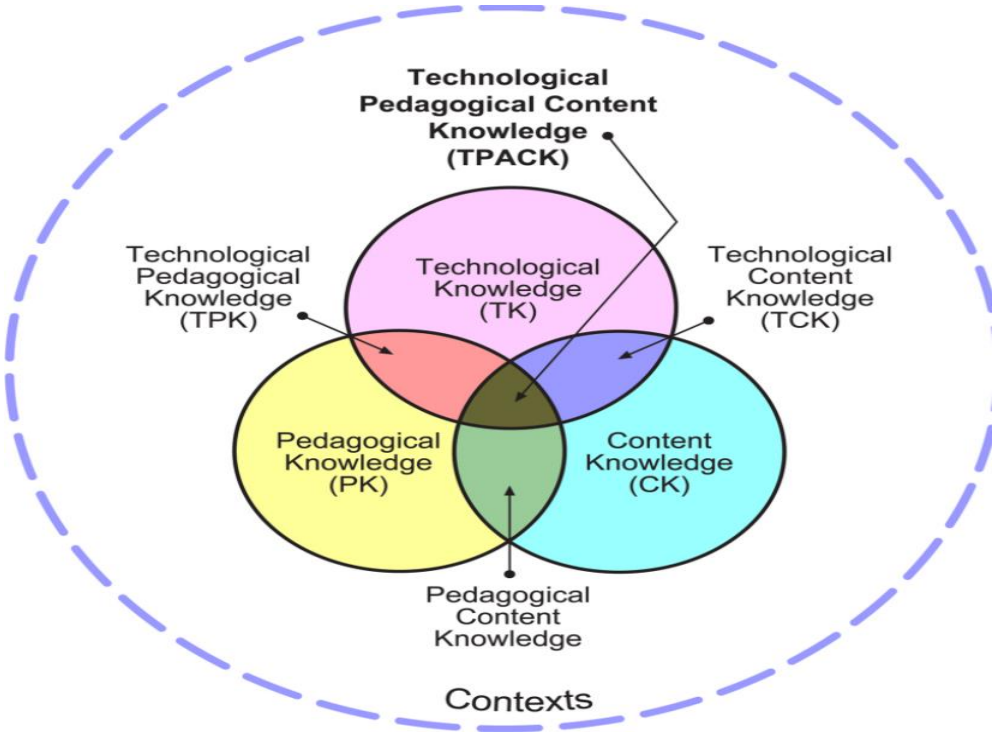

Figure 1. The model of the TPACK framework

Technology knowledge refers to the knowledge about various technologies, ranging from low-tech technologies such as pencil and paper to digital technologies such as the IoT, digital video, interactive whiteboards, software programs, robotics, artificial intelligence, big data, etc, (Kim, 2018). This includes understanding information technology broadly enough to apply it productively at work and in everyday life, recognizing when information technology can assist or impede the achievement of a goal and continually adapting to changes in information technology (Abbitt, 2011). Content Knowledge (CK) is the "knowledge about actual subject matter

that is to be learned or taught" (Voogt et al., 2013). Teachers must know about the content they are going to teach and how the nature of knowledge is different for various content areas. The knowledge would include knowledge of concepts, theories, ideas, knowledge of organizational framework, knowledge of evidence and proof as well as established practices (Kim, 2018; Shulman, 1986). The study of CK is the knowledge of the subject of civil Technology construction. Based on the TPACK framework, it is argued that teachers can use creativity to rethink and reimagine how the demands of the 21st century are changing the boundaries of CK (Kim, 2018; Koehler et al., 2013). According to Shulman (1987), teachers need to understand the subject matter deeply and flexibly so that they can help the student create useful cognitive maps to teach all students according to today's standards (Sani et al., 2022; Shulman, 1986).

Pedagogical Content Knowledge (PCK) covers the core business of teaching, learning, pedagogy, curriculum, and assessment (Smith et al., 2016). Civil Technology construction teachers are mandatory to cover the core business of their responsibility. According to Johnson (2012), good teaching does not happen by chance, but thoughtful planning is needed to create effective lessons and enhance learning. Civil Technology construction teachers are expected to assess hand tools skills during PAT and any other informal activities. Pierce (2002) argued that assessment is a crucial part of teaching and learning. It not only informs instructional decisions made on a day-to-day basis and helps establish student strengths and weaknesses but also affords feedback to students in support of their learning. Technological Content Knowledge (TCK) refers to the knowledge of how technology can create new representations for specific content (Smith et al., 2016). Teachers need to master more than the content they are teaching; they must also have in-depth knowledge of how subject material may be altered by implementing technologies. The ability of teachers is not merely to develop pedagogical or content only in learning, but it requires an understanding of technology so that learning is in accordance with the times in this modern era (Kim, 2018). According Koehler et al. (2013), a teacher must master pedagogic, content, and technological abilities, and these abilities are called TPACK. When simultaneously integrating knowledge of technology, pedagogy, and content, teachers are bringing TPACK into play any time they teach.

METHOD

The study adopted a qualitative approach because it allowed the researchers to combine and assemble all descriptions of events, people, and behaviour (Ramaligela et al., 2015) as far as the significance of hand tools in the 4IR era is concerned. According to Aspers and Corte (2019), qualitative research is an iterative process in which an improved understanding of the scientific community is achieved by making new significant distinctions resulting from getting closer to the phenomenon studied. In this approach, the researchers collected data by interacting with the participants to discover their state of mind, beliefs, and insight to gain knowledge about the researchers' areas of interest. Qualitative data take the form of words, so the researcher keeps a detailed note, records the interviews then identifies categories that help to sort and organize that data (Creswell, 2014).

This study employed a case study research design to explore and investigate the instructional practices of teachers in the civil Technology construction concept, to see the extent of their teaching methods in relation to the 4IR. Heale and Twycross (2018)

define a case study as an intensive study about a person, a group of people, or a unit, which is aimed to generalize over several units. They further define it as a study that aims to provide an intensive, systematic investigation of a single individual, group, community, or some other unit in which the researcher examines in-depth data relating to several variables (Heale & Twycross, 2018). Two districts were investigated because there are only a few technical schools offering civil Technology construction in one district. Nonetheless, the schools were in different districts but all of them are public secondary no fee-paying schools, and they all fall under quintile 4, hence the case study design.

This study was formed and influenced by the interpretivism paradigm also known as the constructivist paradigm. An interpretive paradigm is an approach that aims to understand people. The interpretive paradigm is on the opposite side of positivism and can be viewed as its alternative (Aspers & Corte, 2019). Interpretivism holds the view that reality should rather be interpreted through the meaning that people give to their life world. This meaning can only be discovered through language, and not exclusively through quantitative analysis (Silverman, 2013). Interpretivism assumes relative ontology, subjective epistemology, a naturalistic methodology, and balanced axiology (Kivunja & Kuyini, 2017). The study interpreted the data that was collected from classroom observations and interviews to understand the experience of teachers teaching the concept of Construction using hand tools in the era of the 4IR.

The population in research terms is a collection of items, events, or people having some common characteristic that the researcher is interested in studying. Shukla (2020) says that a population is a set or group of all the units on which the findings of the research are to be applied. Similarly, Dube et al. (2015) defined population as 'the total group of people or entities [social artefacts] from whom information is required. The population of the study comprised 8 secondary schools and their 8 teachers teaching civil technology. There were, however, three schools from district 14 and 5 schools from District 10. Each school has 1 civil Technology class, which translates into 1 teacher per school. Sample refers to the small amount of something that gives information about the thing, it is taken from (Shukla, 2020). In simpler terms, a sample in research is when a small figure of people, derived from a population, is used as a representative of the same population. Non-probability sampling: Purposive sampling to be precise was used to select six educators, 3 educators per district, and 1 teacher per school because some districts do not have schools that offer civil Technology. In total, there were six civil Technology teachers which were ultimately selected to take part in the study. The purposive sampling approach was used to ensure that the researcher reach the main targeted population that is of interest to the study, which best-enabled research questions to be answered and the sampling method was useful for a qualitative approach. The participants were referred to as Educators 1, 2, etc.

Since the study is a qualitative study, the researcher implemented two data collection techniques, which are classroom observation and semi-structured interviews. The researchers selected the observation technique because the data collected from observation was of greater accuracy, and the researchers did not have to depend on the data provided but on the data that was directly observed for reliability purposes. The researchers also used interviews because interviews are often important instruments in qualitative research, and they can be done in both

structured, unstructured, and semi-structured ways. In addition, interviews allow for a lot of qualitative data that can also be recorded for further use. The classroom observation schedule was adapted and designed from the TPACK framework components to avoid deviation from the underpinning framework of the study. The classroom observation data was analysed descriptively with notes taken during each activity that was performed which was in accordance to the TPACK framework. The researchers visited the sampled schools 3 times to do an in-depth lesson observation on how teachers teach theory and practical lessons and how technology was integrated into their teaching methods. The researchers observed one theory lesson and two practical lessons. The semi-structured interviews were conducted, and audio recorded. Interviews were conducted with six civil technology construction teachers. The researcher developed the interview items and the session lasted for 30-40 minutes. The TPACK theory too was used to assist in drafting and framing the interview questions. After data collection was completed, the observation data were analysed as per the observation schedule. As the data was analysed special attention was given to the TPACK components. The results were then narrated to provide an accurate reflection of the observation. Therefore, data were descriptively analysed using the TPACK concepts which form part of the study framework. Then the interview data were analysed descriptively using verbatim quotes. Yet again, confidentiality in the information conveyed by participants was maintained and the data collected was only used for the purpose of this study. The anonymity of schools was safeguarded by referring to them as schools A-F. In the interviews, participants were referred to as Educator 1-6 ("E1-E6").

RESULTS AND DISCUSSION

Classroom observation findings

The classroom observations responded to (1) The readiness of the civil Technology construction teachers for the 4IR; and (2) The civil Technology teachers' instructional practices in the construction concept**.** The classroom observation schedule was adapted and designed from the TPACK framework components to avoid deviation from the underpinning framework of the study. The researchers observed three lessons in each school, one theory lesson that lasted for an hour and two practical lessons that were two hours each lesson.

Teachers' CK and TK on the concept of construction

In the observations, teachers displayed good CK of tools and equipment because most of them demonstrated similar concepts and approaches to teaching the content of the topic. Construction tools and equipment were well introduced by outlining the importance of the knowledge of the topic at hand in the construction industry. The tools and equipment were discussed in depth with their correct uses, and lastly, the teachers discussed the safety aspects associated with tools and equipment, which is often a necessity in the construction concept. All aspects that are stipulated in the annual teaching plan (ATP) were taught. Learners enjoyed what they were doing, and teachers knew what they were teaching but the issues of efficiency were compromised without technology integration.

We also observed that teachers have a huge gap in advanced technical knowledge. During the theory lesson, all the teachers were using textbooks, classwork

books, pencils, and a chalkboard. Educator 1 also used an overhead projector to show learners videos and Educator 4 also showed learners videos on YouTube. During practical lessons, all teachers were using the tools that were invented during the 1st to 3rd IR. The learners were taught how to use tools such as spirit level, bricklaying trowel, steel square, steel pegs, saws, drill, drill press, and angle grinders, which are no longer as often used in technologically inclined industries. The teachers were not using the advanced technologies that are aligned with the 4IR. It was also observed that teacher practices do not prepare learners for the future (4IR), but they are doing PAT to meet the requirements of the subject since the practical component of the subject is compulsory. For example, learners were doing different PAT, because teachers chose a PAT that they find easier or the one that they have resources for. Yet again, other educators said if learners do not finish, they would mark whatever is available to avoid awarding a learner a zero.

Teachers' PK and TPK

The researchers observed huge gaps in theory lesson planning. Teachers did not have lesson plans and that hampered effective teaching and learning. The researchers also observed good practices in assessment where all participants administered assessment at the end of the theory lesson either in a form of classwork or homework. Moreover, during the practical lesson, learners were given a copy of the assessment with instructions and the marking rubrics so that they (learners) know exactly what criteria the PAT should meet. In addition, the researchers observed good practice in teaching methods where the teachers used a variety of instructional methods to deliver content. Again, Educators 3 and 6 were teaching the theory lessons using tools for demonstration, with no evidence of 4IR concepts.

The researchers also observed a massive gap in teachers' TPK. Teachers were not using technology in their hand tools skills teaching. All the teachers observed were just using the basic hand tools such as bricklaying trowels, spirit levels, wooden pegs, shovels, wheelbarrows, etc to teach learners hand tool skills the is no technology integration. The teachers' practice in this aspect is not in line with Stenger (2017), that the use of VR simulations can help vocational learners to learn practical or essential skills in a safe environment. Educator 4 had an interactive smartboard, but it was only used as a whiteboard to project notes and play videos.

Teachers' Development of TPACK

According to Kim (2018), TPACK" or "TPCK" refers to a specific type of knowledge that intersects with all three: content, pedagogical, and technological knowledge. According to Pamuk (2012) study, high school teachers demonstrated a lack of TPACK and had a difficult time developing intertwined knowledge such as TPK or PCK. Although they had well-grounded technology backgrounds, they displayed limited TPK. The researcher observed that teachers failed to develop lessons that are in line with the TPACK framework. Both theory and practical lessons were not integrating technology. There was no reflection of 4IR technologies such as VR, IoT, AI, robotics, etc. As discussed above in theory lessons teachers used textbooks and a pen. What teachers are using is not in line with what Libusha (2019) said, that the time has come for educators to start relying on something more than just a pen and paper or chalk and board. In addition, Educators 2 and 4 used overhead projectors and smartboards to play videos and the smartboard can do more than being

used as an overhead projector. The observations display a gap in the technology pedagogical knowledge of the teacher which Kim (2018) alluded to when it was mentioned that teachers often fail to intertwine knowledge such as TPK or PCK during instructional practices.

The observed teachers lacked TPK and without TPK in teachers, schools are then not preparing learners for the 4IR era. Schools are not ready with the 4IR technologies, and the lesson presented by teachers were not integrating technology. Smith et al. (2016) investigated the relationships between preservice middle school mathematics teachers' beliefs and their TPACK. Preservice teachers' TPCK levels were the lowest among the TPACK components, and preservice teachers with sophisticated and student-centered beliefs about mathematics, learning and teaching, and technology use displayed higher CK, PCK, and TPCK, respectively than preservice teachers with traditional or teacher-centered beliefs. Thus, preservice middle school mathematics teachers' beliefs about mathematics, pedagogy, and technology use are aligned with their levels of TPACK components. This, according to Smith et al (2016), could be attributed to the lack of resources and training that teachers continue to be deprived of. Again, this aspect is not in line with Shava and Hofisi (2017), that the government needs to be ready to adapt to changes presented by the 4IR.

All the observed schools lack resources and the appropriate technologies therefore, technology is not integrated. All the observed schools were doing different PAT; the teachers were choosing a PAT that the school would have resources and tools to carry out. Again, learners were working in groups so that the hand tools would be enough for all of them. Educator 5 did not even have enough basic tools because his learners were waiting until others were done then they would be able to do their PAT. This adds to what Smith et al. (2016) claimed that lack of resources and training keep on demoralising teachers in their endeavours of technology integration in the classrooms. The teaching methods that are used are not preparing learners for 4IR. Teachers used the lecture method where learners would be listening for the whole period. In this aspect, the observation was not in line with Kennedy (2019), that 4IR not only affect what children learn but also how they learn.

Schools may use different technologies such as robotics to prepare learners for 4IR. These technologies in the Construction industry come with many benefits. The observation revealed that teachers are teaching learners skills of using hand tools whereas already there are machines that can do the same task. According to Repp (2018), robots can excel at repetitive tasks in a controlled environment. The construction site could not be more opposite. Robots like Hadrian could reduce operating costs and waste, as well as provide safer work environments and improve productivity. Hadrian can build the walls of a house in a single day, which is much faster than conventional methods (Matthews, 2019). Therefore, if teachers are not enforcing their teaching to accomplish that, the construction concept that is currently being taught in South Africa is not going to benefit the learners which will, in the end, add to the ever-increasing unemployment rate. The 4IR is here, teachers need to be technology inclined so that they prepare learners that would meet the demand of future workplaces.

Semi-structured Interview findings

The interviews with each teacher took about 30- 40 minutes. The interview questions were intended to respond to the following issues (1) The significance of

hand tool skills in the construction concept in the 4IR era; (2) The readiness of the civil Technology construction teachers for the 4IR; and (3) The civil Technology teachers' instructional practices in the construction concept**.** Below are the questions and responses that happened between the interviewers and the participants. The interview analysis was done using verbatim quotes from the participants' responses.

How does the department of education prepare the schooling system for education 4.0?

Most teachers mentioned that little to nothing is being done to prepare the schooling system for the 4IR. In response to the above question, teachers said the following:

> Educator 1: *"Nothing is being done"*
>
> Educator 2: *"Nothing is done to prepare teachers for 4IR, teachers attend workshops where they do practical using the same old hand tools such as wheelbarrows, spirits levels, and bricklaying trowels. Again, cluster meetings that are organised by the district attended by teachers to be capacitated on how the theory part of civil Technology can be taught"*
>
> Educator 3: *"The department of education is not doing anything so far that relates to preparing teachers for 4IR"*
>
> Educator 5: *"our department is always making promises without action. Up to date only those educators who are into books and technologically literate can tell you about 4IR. There is nothing that is in place that prepares teachers for the 4IR"*

The second question asked was about what technology is and how can it be integrated into teaching and below are how the responses went:

> Educator 1: *"Technology is the use of smartphones and projectors. It can be integrated by using construction machines instead of hand tools"*
>
> Educator 2: *"Technology is the modern way of life and how to do things simply. Through technology hand tools can be learned by showing learners videos of how to use some of the tools they are familiar with, technology can also be used to show learners where the tools originated and how they can take care of the tools"*
>
> Educator 4: *"Technology is when you apply skills and knowledge to do work with less effort. Technology can be integrated by using devices such as a driller instead of screwdrivers, concrete mixers instead of a hand mixing concrete by shovels, and lifting heavy materials by means of a lifting mechanism"*
>
> Educator 6: *"Technology is the use of the technological process to solve problems"*

The other question was on the teachers' challenges in integrating technology in teaching Construction hand tool skills. Below are the responses:

> Educator 1: *"We do not have resources, learners don't know some of the hand tools because we don't have them at school, without the tools we can't teach the skills of using them"*

Educator 3: *"Resources are not enough at school and teachers are not prepared to integrate technology"*

Educator 5: *"The challenge is the availability of these machines which are the technology tools"*

Educator 6: *"We don't have the resources required to integrate technology; we don't even have enough basic resources to teach hand tools skills"*

The other question that was asked to the teachers was about getting their opinions on the skills that will be needed in construction in industry 4.0. Below are the responses:

Educator 1: *"I don't know"*

Educator 4: *"Computer literacy, technical skills and knowledge, software and digital world understanding, and creative thinking skills"*

Educator 5: *"Computer literacy people would be the most needed personnel in the Construction industry"*

Educator 6: *"Computer usage skills and operating of machine skills"*

Discussion of Classroom Observations Results

During the classroom observations, teachers knew what they were teaching but the issues of efficiency were compromised without the lack of technology integration. Content knowledge is the "knowledge about actual subject matter that is to be learned or taught" (Kim, 2018). According to Smith et al. (2016), knowledge of content is of critical importance to teachers. Teachers must know about the content they are going to teach and how the nature of the information differs from numerous content areas, and that is what they tried to display in class.

The teachers' instructional practices were dominated by manual practices where the use of hand tools was prevalent due to a lack of resources. This then made some learners not finish their PAT because all tasks were done manually, and they were not taught adequately how to use some of the hand tools. Had the technology (robotics) been used, perhaps learners would have finished their PAT because technology makes life better. The learners' practices were not in line with Xu et al. (2018), who said that much as robotics and other features are seen as disruptive, they are the concepts that are needed today. In addition, Soffar (2015) also argued that automation in construction reduces the construction time, improves the safety of labours, enhances the quality of work, ensures accuracy and precision, and improves efficiency in construction. Learners may spend less time doing their PAT if technology is integrated into civil technology construction teaching. According to construction Robotics, a Semi-Automated Mason (SAM) bricklayer robot can place between 800 to 1200 bricks a day, compared to human being who can only lay around 300 to 500 bricks a day (Kurien et al., 2018). Again, another brick-laying robot called Hadrian the bot can place 1000 bricks an hour (Multani, 2021). This means that the education system should embrace technology since the demand of the 4IR is technological advancement. According to Mtshali and Ramaligela (2020), the contribution of the civil Technology construction concept to the 4IR is basically dependent on whether learners are being prepared with the required knowledge and skills that would make them ready for the world or field of work.

On the issue of PK, the researchers observed huge gaps in lesson planning. Teachers did not have lesson plans and that hampered effective teaching and learning. The teachers' practice in this aspect does not concur with Johnson (2012), that good teaching does not happen by chance, but thoughtful planning is needed to create effective lessons and enhance learning. Pedagogical Knowledge is teachers' deep knowledge about the processes and practices or methods of teaching and learning**.** Pedagogical knowledge refers to the methods and processes of teaching and includes knowledge in classroom management, assessment, lesson plan development, and how learners learn (Smith et al., 2016).

The educators' practices in this aspect were not in line with what was said by Straessle (2014), that an effective teacher must be an effective planner of a lesson as the decisions that he or she makes, directly impact each individual in the classroom on a daily basis. However, in their teaching method, they all lacked technology integration, which was not even reflected in the none-seen lesson plans. There was no evidence of technology usage in their practical lesson and that means these learners might not be ready with the 4IR skills when they finish their basic education, and they may be unemployed due to that. The teachers' practices do not concur with Manda and Ben Dhaou (2019) who said, the 4IR demands a "new breed of worker, one that is skilled, innovative and technology savvy" therefore raising the need for new 'future' skills which possibly do not exist to ensure human aren't replaced through automation.

On the observation of the teachers' TPK, it was found that the teachers' practice in this aspect was not in line with Stenger (2017), that the use of simulations can help vocational learners to learn practical or essential skills in a safe environment. Technological Pedagogical Knowledge refers to the knowledge of how various technologies can be used in teaching, and the understanding of how teaching and learning can change when technologies are used in a particular way (Koehler et al., 2013). Educator 4 had an interactive smart board, but it was only used as a whiteboard to project notes and play videos. The educators' practices did not concur with Tcherneva (2018), that teachers from technical schools are mandatory to have a thorough knowledge of different trades and practical engineering experience, equipped with this knowledge. Again, the educators' practices did not concur with Sharma et al. (2011) that ICT helps facilitate the transaction between producers and users by keeping the students updated and enhancing teachers' capacity and ability to foster live contact between the teacher and the student through other means of technology.

Teachers' Interview Discussions

According to the teachers' responses, they do not know the skills that would be needed in the 4IR because Educator 1 did not have an idea of what skills are needed and Educator 2 said that using environmentally friendly material would be the key skills needed. The teachers' responses disagree with the discussion by the World Economic Forum (2016), claiming that the 10 skills to thrive in the 4IR across industries include, complex problem solving; critical thinking; creativity; people management; coordinating with others, etc. On the issue of what skills should the school prepare the learners with, particularly in the Construction sector, the teachers' responses were not in accordance with Mtshali (2020), that civil Technology as part of technical education in South Africa should prepare learners to succeed in the future through

the acquisition of critical thinking skills. Their responses were housed within their assertion that they do not have resources to teach with. Mtshali (2020) and Manda and Ben Dhaou (2019), stated that the 4IR demands a "new breed of a worker, the one that is skilled, innovative, and technology savvy" therefore raising the need for new 'future' skills which possibly do not exist to ensure human aren't replaced through automation. But with the lack of resources, teachers can do so much.

Teachers also shared their outcry on how the DBE fails them in integrating technology. According to the teachers' responses, they aren't prepared with the 4IR skills hence, they aren't preparing the learners because, in their responses, most of them mentioned that the DBE is not doing anything to prepare civil Technology teachers with 4IR skills. Teachers lack the technical knowledge and that means they aren't using the appropriate technologies in their teaching. In their responses, they mentioned that the district skills training that they attend is hand tools skills-based training. This is not in accordance with countries like China which is on track to be the leading country in installing VR and AR in the classroom setting across the nation (Alhadeff, 2018). China, through the municipal and national governments, has been investing heavily in this industry, more so than other countries (Alhadeff, 2018). Again, the responses are not in line with MacQueen's (2021) that VR training and education are literally changing the way people learn, by delivering lessons and training that are either not practical or even possible in the real world". While other countries are investing in 4IR technologies in schools, the South African education system is left behind.

Similarly, Kamaruzaman et al. (2019) conducted a study in Malaysia to establish which skills would be required in the 4IR by engineering graduates and related fields such as the built environment. The study revealed that ten key skills would be required explicitly; analytical thinking and innovation; active learning and learning strategy; creativity, originality, and initiative; critical thinking and analysis; complex problem solving; emotional intelligence; and system analysis and evaluation would be preferred skills as well as technology design and programming; leadership and social influence; and reasoning and problem-solving.

Kennedy (2019) also claimed that school curricula in all subjects should facilitate creative thinking, critical thinking, and problem-solving skills for learners to be prepared for the 4IR era. Teachers deliberated that the skills that would be needed in the construction industry in the 4IR era would be computer literacy skills. That means the learners that they are teaching would not have the needed skills in the construction industry because teachers don't know the skills needed to prepare learners for the future. Moreover, according to Tcherneva (2018), teachers from technical schools are mandatory to have a thorough knowledge of different trades and practical engineering experience, equipped with this knowledge, these teachers will know which employability skills industries need and will ensure that their teaching method prepares learners for the reality of work.

CONCLUSION

The study's main aim was to investigate the significance of hand tool skills towards 4IR in the construction concept in the six schools in South Africa. The study findings revealed that teachers have a construed understanding of what technology is. Teachers don't necessarily understand what technology is in relation to teaching civil Technology construction. Teachers also lack an understanding of what 4IR is and

how they can prepare learners for 4IR. Again, teachers don't know the skills that would be needed in the construction industry in 4IR workplaces. If teachers don't know the skills that would be needed in 4IR it is most likely that the learners that they are teaching would not have the needed skills in the construction industry. Teachers' teaching methods are not preparing learners for 4IR. While other countries are investing in 4IR technologies in schools, the South African education system is left behind. The study findings also discovered that the reason for not integrating technology into teaching civil technology construction is due to the unavailability of the 4IR technologies or resources in schools.

RECOMMENDATION

The study recommends that the construction concept in civil Technology needs to be taught technologically. Teachers need to be equipped and trained with technological knowledge to teach the construction concept. The in-house training that the DBE organises should be technology dominated across the civil Technology concepts so that learners can be prepared for the future. It would be imperative for the 4IR skills to be embedded in the practical component of the concept to prepare learners for future work and to ensure that they are ready upon completion at school. Teachers too, need to be trained because technology is changing greatly, and they need to keep up with the latest technological trends.

ACKNOWLEDGMENT

No specific grant or funding was given to this educational research from any private institution, public organization or nonprofit corporation.

Declaration of interests

The researchers declare no conflict of interests.

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