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Pedagogical Capital Strategies for Civil Technology Skills-Based Activities

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Abstract. Exercising pedagogical capital in a skills-based subject like Civil Technology requires sufficient knowledge and skills about the built environment and its functions**.** The purpose of this study was to explore reasons behind the enactment of pedagogical capital among Civil Technology teachers, when engaged in Practical Assessment Tasks (PATs), with reference to the growing demands placed upon them to plan, execute, and assess local and context-driven skills-based activities. This study purposefully sampled seven Civil Technology teachers, offering Civil services, Construction and Woodwork disciplines in Limpopo province. The two data-collection methods used were semi-structured interviews and observations, where thematic analysis was employed. In addition, this study was guided by a pedagogical capital framework. The findings of this study revealed that teachers used their pedagogical capital because they were interested in learning how to execute planned or self-designed skills-based activities, in order to overcome skill shortages and that they needed to respond to the collective needs of their community amongst other things. This study further discovered that Civil Technology teachers were continuously working towards achieving their pedagogical capital expertise. However, they were met with challenges of connecting with industries and procuring sufficient training tools, among other things. Hence, this study recommended that the department of education should assist teachers in connecting with industries, learn new and innovative PAT design projects and support teachers with tools and equipment to maximise their pedagogical capital. This was a serious challenge for teachers to successfully invoke their pedagogical capital.

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1. Introduction

The deployment of pedagogical capital by teachers in skills-based subjects like Civil Technology is essential in promoting industry-based learning experiences to learners. Pedagogical capital advocates innovative and artistic teaching techniques that promote efficient practices, social and cultural production, and self-reflection, so that learners acquire meaningful learning experience (Henningsson-Yousif & Aasen, 2015). Teacher socio-cultural experiences, technological awareness, professional learning communities, and Pedagogical Content Knowledge (PCK) are some of the essential elements in their pedagogical expertise. This means that for Civil Technology teachers, the success of any skills-based lesson they conduct is reliant upon their pedagogical capital expertise. It is for this reason that this study sought to understand why Civil Technology teachers employ their pedagogical capital the way they do when engaged with skills-based activities, such as Practical Assessment Tasks (PAT).

Practical Assessment Tasks (PAT) or skills-based activities are administered in schools to prepare learners for real-world opportunities (Mtshali, 2021). Through these PATs, it is expected that learners will be equipped with knowledge and skills that would render them active participants of this extremely digitised economy. In fact, teachers are expected to activate their pedagogical capital to ensure that each learner is skilled, technologically advanced and adapts easily to social and economic activities. It is in those areas that we must know why teachers employ their pedagogical capital in the way they do; sinace they are central to learners' conception of digital and socio-cultural skills.

According to Nkwanyane et al. (2022) Civil engineering students have not made visible strides in the economy over the past decade. This is because they lack the essential skills to form part of the economic growth. Patricia et al. (2023) adds that it is not surprising that technology learners are uncompetitive and sometimes unskilled, their very teachers lack the essential creative pedagogy when engaged with PAT. Nevertheless, this study is interested in teachers' enactment of pedagogical capital and their reasons therefore. As such, it is our view that not much has been done regarding the concept of pedagogical capital in Civil Technology, especially when one is looking at skills-based activities like PAT. Consequently, this study seeks to fill that research gap.

2. The Literature Review

2.1 Civil Technology structure (discipline) and the need to incorpoarate pedagogical capital

Civil Technology is a school subject that deals with the Civil Engineering world that contributes the most to the world's materials; as most people depend on its structures for shelter, recreation, transport, basic living activities etc. (Schmidt & Osebold, 2017). This consists of construction, civil services, and the woodwork disciplines (Mtshali & Msimango, 2023). Essentially, construction discipline deals with siteworks, foundations and superstructures; while civil services deal

with plumbing works, which consist of water supply and drainage systems; and woodwork, focusing on carpentry, which includes timber joinery and manufacturing (ibid). Civil Engineering has evidently driven the growth of numerous countries; and it continues to contribute enormously to hands-on skills, manufacturing, the design process and craftmanship (Mtshali, 2021).

Civil Technology skills continue to play a major role in the global skills' capacity and working with technologies. On a daily basis, Civil Engineering yields new technological products and practices, in order to ease the pressure on slow traditional engineering business. For instance, in Civil Engineering there is now a home-building 3D printing robot that specialises in making walls, rooves, and the floors of a 650-square-foot model in as little as 12 hours. These are major indications of a non-stagnant engineering sector. We draw a correlation between the above argument and Civil Technology practical assessment tasks; because this is where it all began.

Before we emphasise the need to utilise pedagogical capital, we need to firstly draw the attention of the readers to perennial curriculum changes that the Civil Technology subject has undergone, which subsequently gave rise to the need for teachers to exercise their pedagogical capital. Since 2005, Civil Technology has been taught with the intention to produce learners who will, after school completion, enrol for an apprenticeship and get trade test certificates through learnership programs. However, this intention was not fulfilled, given that the subject lacks proper content knowledge, the weighting of topics, skills, and focus (Pinnock, 2011); and it needed to be revised.

Consequently, the National Curriculum Statement (NCS) was introduced; but it was later discovered that it also lacks the proper sequencing of concepts, progression of knowledge development, clear teaching methods and knowledge focus (Du Plessis et al., 2015). It was inevitable to amend NCS, which gave rise to Curriculum Assessment Policy Statement (CAPS), under which the current Civil Technology operates.

This Curriculum Assessment Policy Statement (CAPS) is structured to respond to the urgency to prepare learners with contemporary industrial skills. With that in mind, teachers are expected to design and execute local and context-driven PATs – which require a great deal of pedagogical capital strategies. The CAPS is basically giving teachers freedom to prepare and execute hands-on skills-based assessments that are crucial to the needs of their communities. As a result, this study unearths cutting-edge literature that has never been explored among Civil Technology teachers.

According to Mathabatha et al. (2022) technology teachers need to actualise creativity and critical thinking skills through PAT; consequently, we argue that creativity and critical thinking can instinctively emerge, when the teacher evokes his/her pedagogical capital. This study will expand on the concept of pedagogical capital in the conceptual framework section. Nevertheless, the primary goal of this study is to understand why Civil Technology teachers

practise their pedagogical capital the way they do when engaged with skills-based activities. The guiding question is thus:

RQ: Why do Civil Technology teachers employ their pedagogical capital the way they do, when engaged with skills-based activities?

2.2 The necessity for skills-based activities in Civil Technology

Apart from complying with normal progression standards and imparting knowledge and skills, skills-based activities in Civil Technology give an opportunity for learners to understand the working environment outside school premises (DBE, 2011). It prepares learners with a basic understanding of why the built environment operates the way it does; and what has been and will be its role in former and future industrial revolutions. So, careful planning, teaching and assessment of these activities are done by teachers for industries' consumption. It is unfortunate that industries are not involved in the planning and assessment of these skills-based activities.

The biggest concern now is that teachers work in silos and Magolego et al (2022) warn us that such a practice increases the possibilities of industries to doubt the quality of skills that learners are receiving. Who can blame Magolego et al., when Maeko (2022) stated that Civil Technology teachers enjoy teaching theory more than practicals. The above-mentioned authors give us confidence to pursue our exploration of why Civil Technology teachers use their pedagogical capital the way that they do.

We are also driven by the views of Ayentimi et al. (2018) that schools, TVET Colleges and Universities have not been explicitly clear on why they do not involve industries in designing hands-on practical skills activities for their learners. Yamada and Otchia (2020) postulate that there is a great skills mismatch between skills given to learners and those that industries expect. A fair argument is that the views of Yamada et al. are not new in the vocational education sector. This can be hinged on studies, such as that of Rodzalan et al. (2022) looking at TVET skills gaps in the electrical and electronic industries, along with Ibrahim and Nashir (2022) focusing on demand-supply mismatch in TVET learning programs, these scholars echo Yamada's sentiments. It is for this reason that we are premised on the view that little has been done to understand why teachers teach the way they do. This study is interested therein, with a special focus on their pedagogical capital.

According to Baum and Krulwich (2016) practical activities are employed to ensure that learners receive similar training to that of artisans. Supporting this claim is that of Fiebrink (2019), who posits that these practical activities assist learners to know how machines operate and how they can fix them, should the need arise. We are thus interested, as a persuasive argument in the research focus, if teachers hold similar views when engaging with skills-based activities. The following section discuss the methodological aspect of this study.

3. The Methodology

3.1 Research approach and design

To understand why Civil Technology teachers, employ their pedagogical capital the way they do, when engaged with skills-based activities, this study used a qualitative research approach. According to Yin (2013) the qualitative approach in research is where the researcher attempts to collect rich descriptive data in respect of a particular real-life phenomenon. Consequently, this study was concerned with collecting data and describing why teachers conducted skills-based teaching in the way they did. This was with the intention to develop an understanding of what is being studied (Yin, 2013).

This study used qualitative research with the understanding that the data collected were going to produce words, rather than statistics, as the data for investigation (Ravitch & Carl, 2019). A single case study design was deemed relevant, as the case in which Civil-Technology teachers in Limpopo Province of South Africa. This research design is supported by stating the Civil Technology teachers' views.

3.2 Sampling and the sampling method

In keeping with Denscombe's (2017) statement that sampling is a practice of choosing a sample unit from a population of interest, the selection of participants for the study was guided by the research approach. Both purposive sampling and convenience sampling were used for the study. The criteria of the case-study design required that participants to be deliberately selected. Purposive sampling is described by Campbell et al. (2020) as the sampling where the selected individuals, as research participants, are knowingly chosen because of their suitability for advancing the purpose of the research. The criterion for the selection of participants in this study was that they were teachers of Civil Technology. Convenience sampling was also espoused. According to Maree (2013) as supported by Ngozwana (2018), convenience sampling refers to "situations when population elements are selected, based on the fact that they were conveniently available" (p. 177).

The geographical context of Limpopo province was selected for its' convenience: the principal author lived and worked in Limpopo province during the course of this study. Consequently, there were seven (7) schools convenient for the author that offered Civil Technology during the data collection. Each school had a Civil-Technology teacher. All seven teachers who taught Civil Technology were invited to participate in the study.

3.3 The Data Gathering

This study primarily used semi-structured interviews and non-participant observations to explore the phenomenon under scrutiny. According to Kallio et al. (2016), semi-structured interviews are an effective method for data collection when the researcher wants to explore the participants' thoughts, feelings, and beliefs about a particular topic. This study was thus interested in understanding teachers' thoughts about why they utilise pedagogical capital in the way they do. Marietto (2018) stated that non-participant observation is a data-collecting technique that involves observing and recording the data of participants, when

conducting a case-study research. Thus, this study observed the participants without taking an active part in the situation playing out.

All seven Civil Technology teachers were interviewed and observed using audio-visual gadgets recording of the data. According to Cohen et al. (2018) the benefit of using audio-visual recordings is that the researcher focuses more on listening, asks for more clarity on questions that relate to the research and seek an in-depth understanding on the cause of actions during observations, written documents and questions. Pseudonyms were used for each participant, for example, the first participant was termed as teacher A, whilst the last one was teacher G.

3.4 The Data analysis

To make sense of the collected data, thematic analysis was used for sorting and the sifting of data, to help identify alike patterns (Lester, Cho & Lochmiller, 2020). This was in line with Clarke, Braun and Hayfield (2015) that thematic analysis is used to identify, analyse and interpret the patterns into themes within the data. In order to analyse, we engaged in the following steps of analysis:

- Familiarisation with the data

We familiarised ourselves with the transcripts and recordings to start writing down the notes. This was because Brown and Stockman (2013) advised us that we need to familiarise ourselves with the research data collected by reading, watching and listening to the audio recordings.

- Generating initial codes

After having the grasp of the data, we initiated codes. According to Braun and Clarke (2014) coding involves creating codes for the significant attributes of the data collected, with a specifaic relevance to the research question.

- Searching and review themes

Immediately after coding, we sorted them and identified those which were similar. This then allowed us to create themes. Braun and Clarke (2014) stated that this process includes the grouping of the codes together that share similarities, so that it can reflect a comprehensible and meaningful pattern in the data. We then examined all the themes in the light of the coded data, in order to see whether any logical patterns emerged. This allowed us to recognise the distinct themes; and show how they were combined to tell a narrative by using the data.

- Defining and naming themes

It was inevitable to name the emergent themes after the whole process was completed. We were conscious of what Friese, Soratto, and Pires (2018) said that we should be aware of what each theme is about; and that themes must give the person who is reading the report a sense of what the theme is about.

So, the whole process assisted us to write a report by interlinking the analytic narrative and data extracts, in order to convey to the reader a cogent story about the data in relation to the literature.

3.5 Ethical considerations

Ethical clearance was sought from the ethics committee affiliated to the authors, after which permission was granted to carry out the research within acceptable ethical boundaries.

4. The Conceptual Framework

This study employed Shulman's (1986) ideas on Pedagogical Content Knowledge and Bourdieu's (1986) notion of social capital. Cohen, Manion and Morrison (2018) uphold the view that a conceptual framework draws on theories, and maps out key concepts that are intertwined with the topic, data generation method and the analysis. As a result, this study intertwined the concepts of this scholar to come up with the concept of Pedagogical Capital.

Shulman's (1986) PCK introduced subject-matter knowledge, curricular knowledge and PCK, as the basis for teachers to master content, know-how to transfer content and how it links to other contents within the same curriculum.

According to Shulman (1986), Subject Matter Knowledge (SMK) is knowledge that a teacher delivers to learners to advance the discipline or subject. This study used SMK to explore how much do Civil Technology teachers know designing and executing PAT; since it is the backbone of the subject. Curricular Knowledge (CK) refers to the teacher's understanding of the range of programs designed to teach a particular subject (Shulman, 1986). This study used CK to understand why teachers practise their pedagogical capital the way they do, when engaged with skills-based activities. PCK is described as knowing what makes learning specific topics simpler or more difficult. It is also the knowledge that includes both subject matter and pedagogical expertise (Shulman, 2007). As a result, PCK was used to investigate how Civil Technology teachers teach skills-based activities.

As indicated earlier, this study also used Bourdieu's (1986) social capital concepts. Bourdieu (1986) contended that social relationships are resources that can lead to the development and accumulation of human capital; it is worth noting that social capital is not readily or automatically available to individuals or members of a group. Instead, social capital is acquired by individuals or members of a group, who make the effort to advance themselves, achieve positions of power and status and by developing goodwill (Bourdieu, 1986). Simply put, this means that social capital is an amalgam of the resources, networked relationships (personal and professional), influence, opportunities (or the lack thereof), the recognition and power that an individual has via social, economic, or cultural structures.

For Bourdieu, social capital is intrinsically connected to cultural capital, economic capital, and symbolic capital. Bourdieu (1986) succeeded in grounding his theoretical contribution into the real-life context. However, his conceptions of

social capital were based on sociology and would need further contributions to transfer them into educational studies. Claridge (2015) supports this view by stating that social capital theory can be used beyond the ambits of sociology if the "capital" concept is correctly understood. Based on this, this study used the term "capital" in the context of teachers using their lived experiences, connections, and resources to influence their pedagogy with regard to practical assessment tasks. Therefore, we envisage Civil Technology teachers' pedagogical capital as teacher's ability to use their PCK for learners' conceptual understanding and the grasp of hands-on skills, as well as the capital they bring with them into their teaching. Teachers' capital includes their associations or networks in professional learning communities, social cultural experiences of teaching technology, professional development needs and technological awareness that directly influences subject-matter knowledge and the reasons for pedagogical choices.

5. Findings And Discussions

To reiterate, the research question (why do Civil Technology teachers employ their pedagogical capital the way they do, when engaged with skills-based activities?) was primarily answered by using the data from semi-structured interviews and complemented by the data from classroom observations. Thus, the data that Civil Technology teachers employ in their pedagogical capital ; and why they do because:

- They are interested in learning how to execute planned or self-designed PAT to overcome skill shortages,
- The physical lay-out of practicals and workshop,
- They need to respond to the collective needs of their community,
- There is a need to meet the skills' demand of the Civil Engineering industry, and to
- Respond to the 4th industrial revolutions demands.

Each of the abovementioned were used as themes and elaborated upon below.

a) Learning to implement self-designed or planned PAT to overcome skills shortages.

It is envisaged that Civil Technology teachers should always strike a balance between ensuring that learners have the practical skills they need in the here and now and for the future in dealing with the abrupt transition in skill-sets (Murphy-Graham & Cohen, 2022). To ensure this, CAPS grants teachers the necessary autonomy to design and execute PATs on their own. However, with the lack of training and any kind of continuous professional development, it can be a difficult exercise for teachers to design and execute those PATs bys using their own pedagogical capital. Nonetheless, a PAT enables the teacher to immediately and methodically observe applied competence (DBE, 2011). When creating a skills-based assessment, one of the most important questions to consider is what solutions the envisioned skills would be reacting/ responding to (Daroesman, 2022).

Furthermore, the designer must be aware of who will be using these skills and how crucial they are to their livelihood. By extension, this was an expectation from Civil Technology teachers. As a result, Civil Technology teachers shared their opinions on why they use their pedagogical capital in the way they do; and they pointed to the need of tackling the skills'' shortages (see excerpt below):

> *"I know that South Africa does not have enough technical skills. So, it is our duty as technical teachers to give learners those skills that could result in employment where they live. So, I plan a PAT that will help learners in their home; so it is important to see whether the learners get those skills. I intend them to have these skills. I am certain that all the households in which communities have bathrooms now and the good thing is that they do it themselves. So, teaching learners to join pipes without leakages is a skill that they will forever need; either for renovations, or when they build their own houses or rental rooms."* Teacher A (interviews).

> *"I plan PAT knowing that it will also serve as a reflection on the quality of the skills I give to my learners. As I have mentioned before that this community does not have tarred roads and teaching learners how to make pavements of bricks is important; since it is one day, they may have a business that would help their community to have dust-free streets."* Teacher E (interviews).

Whilst some teachers claim to have designed their own PAT and used their pedagogical capital to see if those PATs lead to the eradication of skills shortages, there were those who took their PAT designs from a textbook or other source (see excerpts below):

> *"I took my PAT from the textbooks which is always aligned with the skills we need in South Africa. All civil services PATs are always geared towards addressing skills that are needed in communities. For example, you will find that many communities are struggling with pipe blockages and sewage running in the street. This indicates that communities always need plumbing skills, hence we teach more on avoiding leakages and dealing with blocking in pipes."* Teacher B (interviews).

Teacher B strongly believes that the current pool of textbooks can address contemporary skills' challenges. Isaac and Manto (2019) confirmed that technology teachers rely more on textbooks to address practical skills' needs and creative abilities. Teacher D used a rare approach that influenced his PAT desig. he consulted with the National Development Plan 2030, which aims to eliminate poverty and reduce inequality by 2030. Certainly, Teacher D's approach was aligned to the view of mass skills provision, so that South Africa can grow an inclusive economy, building capabilities, enhancing the capacity of the state, and promoting leadership and partnerships throughout society (National Planning Commission, 2013), see excerpt below:

> *"I have decided to plan PAT by using the National Development Goals approach. South Africa has a backlog on RDP houses, so I have thought that teaching learners how to build a wall by using a stretcher bond would overcome skills shortages. At least I know that when RDP houses*

> *are built in our community, my learners will also be hired or get tenders. Look, these learners are doing grade 10; and one way to retain them and have them interested in the subject is to teach them what they can easily relate to where they live."* Teacher D (interviews).

During observations, Teacher D learners were indeed engaged with bricks and dry packing them to make a stretcher bond. On the other hand, it emerged that woodwork teachers obtain their pedagogical capital the way they do because they have dangerous working tools in their workshops to which they cannot expose learners now. This meant that for them it was more about safety concerns as opposed to overcoming skills shortages, see excerpt below:

> "*My PAT is guided to do various things; but the main one is that I cannot expose Grade 10s to using sharp dangerous tools. I still need to train them in the basics, it is only in Grades 11 and 12 where I can give them more tangible activities that could be beneficial to their homes."* Teacher F (interviews).

> *"Well, it is our goal to teach learners more of the employable skills; but we firstly need to focus on competence. Woodwork uses dangerous tools and machine so we still need to teach these Grade 10s how to make small things like joint'; and once they have mastered that, we can then assist them to create a chair just like the one that I was demonstrating during the lesson."* Teacher G (interviews).

Collectively, teachers in the civil services and construction fields were able to assure us that their PAT designs met community demands and eventually helped to fill skill gaps. However, in the case of Woodwork teachers, they indicated that, because they use sharp tools, which could be dangerous for Grade 10s; since they have not been fully equipped to operate them, it becomes important for them to focus on small activities that, in time can assist learners to come up with artefacts that will assist their communities. A reference is made from Teacher G's remarks that he teaches learners piece work (joints) with the aim that he will later teach them to manufacture a chair, which can be used in their homes. In other words, teachers F and G were aware that they needed to address community needs and skill gaps; but they also needed to teach learners how to use all the sharp equipment safely and confidently.

b) The physical lay-out (state) of workshops

The physical layout of a workshop plays a big role in performing tasks (Zimmermann-Niefield et al., 2019). Workshops in schools serve as a space where learners can be introduced to some elements of artisanship; as they can demonstrate their skills by using real materials and equipment. Teacher G said that he employs pedagogical capital the way he does because the physical layout of his workshop is filed with all necessary resources for his PATs (see the extract below:

> "*The physical state of the workshop is ready to perform woodwork practicals - almost all the workshops in the schools offering Civil Technology were built for woodwork; as we have a lot of machines for that."* Teacher G (Interviews)

Teacher G's remarks are verified by the Figure 1 below, showing the woodwork tool board.

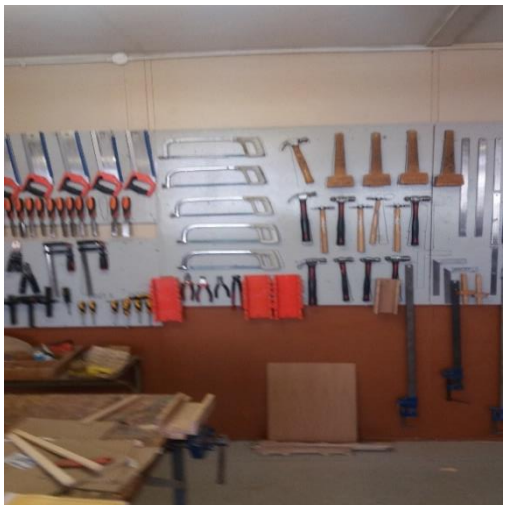

Figure 1: Teacher G's workshop

Also, Teacher G's remarks align with Teacher A's views that most workshops for Civil Technology in Limpopo province reflected the woodwork specialisation more than others, see excerpt below:

> *"The workshop was initially meant for woodwork;, however, learners seemed to not be interested in woodwork, so I introduced civil services because there is equipment, such as steel, copper and PVC pipes that I can be used for the practicals."* Teacher A (Interviews).

Teacher A's note that learners were no longer interested in woodwork was verified by the workbenches that were left outside, thereby showing that they do not use them any more, (Refer to Figure 2 below):

Figure 2: Teacher A's outside workshop

With regards to the physical layout of Teacher F, there was evidence to prove that the workshop was functional; since there was also sawdust in the workshop, showing that learners had used it before .(See Figure 3 below}:

Figure 3: Teacher F's workshop

Nevertheless, there was also a feeling that some teachers did not have secure workshops, leading to vandalism. Theft and vandalism occurred in Teacher B's workshop during the recess; so he shared a workshop with the Electrical Technology teacher. It may be concluded that Teacher B's PAT designs were also influenced by the unavailability of working space (see excerpt below:

> *"Some of the workshops in this school were vandalised with equipment and tools stolen during recess. So, it is difficult to perform tasks, however, we now share a workshop with the electronics group."* Teacher B (Interviews).

Teacher C indicated that the setting of his workshop helps to promote practicals. This were similar remarks from Teachers D and E , in which the teacher said:

> **"***There is enough space in my workshop;, learners can work without disturbing each other. So, I employ my pedagogical capital easily."* Teacher E (Interviews).

Teachers reported that the workshops' physical conditions were suitable for carrying out practical tasks. However, the majority of their workshops were made to accommodate wood-working specialisation. As a scholar and former teacher, we agree with their views in that when specialisations were implemented in schools in 2016, no workshop could be eliminated or demolished on the basis that it would be a waste of money; because woodworking, construction and civil services are somewhat related and may be done in one workshop.

c) The need to respond to the collective needs of their community

Generally, there may be restrictions that can prevent teachers from actively participating in resolving technological (technical and vocational) problems facing their communities (Rakhmonalievna, 2023; Lauglo, 2005). This includes the lack of financial support, political influence, and lack of personnel with the required expertise. It is common course that it is municipalities that need to deliver technological services in their communities; however, schools may have a role to play in resolving some of the community needs. However, teachers said that they apply their pedagogical skills in this way; because there is a need to respond to the community's need (See the excerpts below):

> "*Our school is situated in a place where mine workers used to stay (hostel), and it has since grown over the years and expanded to zones (refereeing to Zone B location). One of the things that we are struggling with is water and there are many leaks on the streets. So, I know that our learners can prevent them in their household because the water pressure is not as strong as it is in the streets.*" Teacher A (Interviews).

> "*Basic service delivery is always a problem in this community. Starting with streetlights that are no longer working, water is no longer as regular as it used to b;, and our community hall is not being maintained. This gives me motivation to equip my learners with construction knowledge and skills, so that they can assist the community; because the school does not have the budget to assist.*" Teacher C (Interviews).

> "*What I can mention is potholes, which affect us and the community at large. When the weather is bad, my colleagues sometimes use alternative transport to come to work, so that they can protect their cars and wheels. It is more than just what I teach that needs to be solved in our community, Unfortunately, most of these things fall out of our curriculum scope.*" Teacher D (Interviews).

Whilst some teachers were well-articulated that their PAT responds to community needs, others had different views in making Grade 10 PAT to respond well with the community's needs (See excerpts below):

> "*I will say I know but there's nothing I can do with grade 10s. Besides, there is not much that we can do as a school in our community; as we work in a short space of time. As you can see, we had to ask learners to come to school during recess, in order to do practicals.*" Teacher B (interviews).

Again, in teacher B's remarks we see time allocation being raised as a factor to equip learners with skills that can solve the community's needs.

> "*This school can only solve issues, such as littering, but, not in engineering-related matters. Those matters need experts in the field; and we are just teaching learners to be acquainted with the field, but also not to merely become certified artisans or engineers when they are done with school. They will still need to go to TVET Colleges or Universities and*

> *be exposed to vigorous work-integrated learning, in order to solve community concerns."* Teacher E (Interviews).
>
> *"I honestly do not think that our school is able to help the community with anything when we are still struggling to procure 4th industrial revolution tools, which is something that could assist us to work speedily in a short space of time. We need to advance like people from Gauteng province; unfortunately, our setting is still far from that."* Teacher G (Interviews).

The results show that teachers are knowledgeable about the requirements of their local community. Most of them, nevertheless, are outside of their area of expertise as teachers. For instance, Teacher C said that the community's community hall is no longer maintained; and that the lamps in the area are broken. In fact, the maintenance of large domestic structures like halls and the installation of lamps are not covered by the contents of Civil Technology. Additionally, Teacher D mentioned how difficult it is for school children to fix potholes in their neighborhood. Once more, this shows that there are wider issues related to Civil Technology (engineering) material, but these matters are not addressed by the curriculum that is taught to learners in Grades 10 through 12.

Another issue was raised by Teacher E, who claimed that his learners are unable to employ the skillsets they have been prepared to address in any real-world problems; since they still require more training from TVET colleges and universities, in order to reach the status of competent problem-solvers. Collectively, teachers acknowledged that their learners are unable to fix the issues that are plaguing their communities.

The above discussions prompted further exploration on community needs, to see whether teachers could work with municipalities; since most of the community's needs fell outside the curriculum scope of Civil Technology in schools.

d) Meeting the skill demands of the Civil Engineering industry

Some theoretical accounts claim that there has been a great disconnect between institutions that offer occupational, technical and vocational training and the industries they are supposed to assist. According to Fafunwa and Aisiku (2022) along with Nkwanyane, Makgato and Ramaligela (2022) state that training institutions like TVET schools, colleges, and universities work in silos in their curriculum designs, content coverage and focus areas in terms of practical activities and work-integrated journals; and this results in gross skills mismatching; as these institutions do not consult industries when developing their curricula. We must remember that designing a PAT is equivalent to designing a curriculum for practical activities. Thus, in the case of schools, one may presume that the industries were consulted by the teachers, as close counterparts in TVET skills preparations. However, little is known as to whether industries were consulted by teachers in prescribing the relevant skillsets for their learners. (Below was their response.)

> *"Yes, I have friends who are working in various industries; and, I normally ask them to sponsor us with old pipes and handigas, so they tell me how they operate, and I take that information into account when I teach my learners."* Teacher A (Interview).

Sadly, only teacher A responded positively to this concern. Other teachers stated that it would be impossible to meet the industrial demands with the kind of PAT they give to learners; and they indicated that they follow a teaching plan. (See excepts below:

> **"***I do not consult any industry representative in planning my PAT; but I follow a teaching plan."* Teacher B (Interviews).

> *"I do not consult because when you ask industries about new skillsets, they think you will compete with them; and they will lose customers. It is better to give a practical that aligns with the content we teach."* Teacher F (Interviews).

Based on teachers' remarks, they do not believe that industries can play an insightful role in prescribing skillsets that are to be taught in their schools. They sighted issues of competition where industries may be reluctant to tell them what gives them business. It is for this reason that Sephokgole et al. (2021) assert that the Department of Basic Education should be the one consulting with industries about skillsets and their relevance so that they can package a responsive curriculum. Even though such a practice is not solving any PAT issues.

According to Mokhothu (2019), most of these individuals are still struggling to quickly understand the contents of the PAT which set by the department. Time is a contributing factor especially when no specific time is allocated for PATs in schools' timetables. Maeko (2022) further claims that the procurement process of tools, equipment and consumables takes time and leads teachers to focus more on theory while waiting for them to come in schools. Thus, it is better to have teachers designing their own PATs.

e) Responding to 4th industrial revolution's demands

In general, responding to the fourth industrial revolution (4IR) demands has not been simple for developing nations like South Africa, even though it continues to have an impact on how people study, live, work, and communicate (Manda & Ben-Dhaou, 2019). Manda and Ben-Dhaou (2019) further stated that business, education, government, and industrial leaders have shown far too little commitment to seizing the opportunities and addressing the challenges of the 4th industrial revolution in Southern Africa. The ministries of digital technologies and communications responsible for developing and implementing an enabling environment for digital transformation and innovation are not proactive compared to developed countries. While there is a sense of belief that 4IR has the potential to address the country's major challenges of poverty, unemployment and inequality, poor policy implementation remains a major challenge. In fact, since 2014, the South African government has developed regulatory mechanisms that address some of the challenges of the 4th industrial

revolution, such as security and privacy; but few of these have been implemented into law to give them legal standing (Manda & Ben-Dhaou, 2019).

What we know though is that 4IR is restructuring the role and activities of education and industries and permeating practically every aspect of life. As new skills are required in response to these ongoing changes, fresh approaches to industry-focused education and skills development are crucial. In-line with this, teachers have highlighted the need to infuse 4IR when engaged with PAT, but also stating challenges that are confronting them (ee excerpt below):

> *"I try to always tell my learners that we need to advance into technology. That is why I think introducing tools that are technologically advanced would make our work much easier. Also, this would give us an opportunity to explore more PAT designs that are not restrictive like teaching learners how to do the water supply in a multi-story building. Currently, I can only teach by using commercial household examples; and that is limiting. So, if 4IR can assist in teaching about higher buildings without expecting that learners will one day need to climb up to demonstrate their competence to connect water-supply pipes. With 4IR, I can quickly send the robot, which will bore a wall on its own and correct it afterwards; and then my learners can simply regulate the instructions."* Teacher A - interview

> *"I do these kinds of PAT because I always ask myself if we still need to teach learners using heavy steel material when in fact, they can use PVC in the lathe machines to quickly join pipes. Even cars now do not use these heavy metals anymore. We need innovation in how we teach PAT. I mean 4IR will not limit us in any way because we can even teach our learners by using virtual reality."* Teacher B – interview

It is interesting that some teachers even stated which parts on the pedagogical structure could advance the teaching and learning of PAT (see except below):

> **"***The biggest advantage we can get is with our tools in that we can be able to mix concrete at a fast rate; and we can even be trusted by our own community that our learners are doing something that can be satisfied by SABS (South African Bureau of Standards;) because the robots would have done quality work. So far, 4IR can assist in so many ways in construction."* Teacher C - interview

> *"I have videos that show how robots know that a house is their own; but because they are expensive, I must still teach learners how to manually build their own house. I am fully aware that if 4IR was to be introduced, a lot of construction jobs would be lost, just as people lost their jobs during the intensive phase of COVID-19."* Teacher D – interview

The urgency to infuse 4IR proved in PAT resources was also highlighted by some teachers. (See extract beneath):

> *"We need to get rid of the old way of teaching learners; because it is limiting them to think that construction is about only paving bricks. There are so many beautiful houses and other structures that are now*

> *done by using glass and all kinds of material. With 4IR, we can be dynamic in our designs and become global competitors."* Teacher E- interviews

> *"With woodwork, we are slowly embracing 4IR because now we have portable machines like our drillers. We need a 3D printer, which can assist in designing beautiful structures like furniture and artistic impressions. I was thinking about this because our school always has an award ceremony for learners; and if we have 3D printers, we can easily design our own trophies made of wood and using different colours."* Teacher F – interviews

Teacher G expressed strong views about including 4IR, see below:

> *"In South Africa, we are still stuck with the third industrial revolution;; we have not even fully embraced it and jumping to the fourth industrial revolution will make things worse, in that our learners would no longer focus on the skills we teach them, but on IC; because machines would be doing everything for then."* Teacher G - interviews

Most teachers accept that the industrial revolution can be used as a strategy to introduce different technologies to assist in instruction within their specialisations. Teachers felt that their current way of teaching limits their learners in terms of creativity and design. This aligns with Ramaboea et al. (2022) that creativity in Technology in the classroom is hampered by teachers' way of content delivery; most of them still depend on old textbooks and hand-outs, duplicating information that is no longer applicable to current teaching practices. So, to push boundaries, virtual reality can be used to explain so many things in a short space of time. For instance, Teacher A cited that he will be glad to teach learners how to connect pipes for water in multi-storey buildings and because it is not safe for learners to do that, robots can make life easier for them.

On the other hand, Teacher G expressed that because South Africa is still in the backlog of embracing the third industrial revolution, the fourth industrial revolution can be delayed; since people will lose their jobs; and that his learners will no longer be interested in the trades that they teach, but rather in ICT.

6. Conclusion and Recommendations

This study was concerned with understanding why Civil-Technology teachers enact their pedagogical capital the way they do. Thus, the findings reveal that teachers were interested in learning how to execute planned or self-designed skills-based activities, in order to overcome the skills shortages; they were influenced by the physical lay-out of practicals and workshop; since they did not have teacher assistants for practicals; and they needed to respond to the collective needs of their communities, amongst other things.

Also, this study displayed that teachers' previous experiences, education background and social interactions influenced their engagement with such activities. Additionally, teachers limited learners with a variety of skills; because they engaged with industries, which this study considered non-substantive in

that learners were not going to do big projects like building tarred roads; because industries would have already given them that opportunity.
Since the researcher has a much better grasp of what the challenges are in making Civil Technology skills and activities, this study recommends that the department should assist teachers in connecting with industries, and in learning some new projects and in supporting teachers with tools and equipment.

7. Limitations and Weaknesses of the Study

This study used a case-study method and selected Civil Technology teachers in several districts of Limpopo province in South Africa as its geographical area. Case study methods may be criticised because the results cannot be generalised. However, Remenyi (2022) supporting Flyvbjerg (2006) highlights single cases of experiments by, or the experiences of scholars, such as Galileo, Newton, Einstein, Bohr, Darwin, Marx and Freud to show that both human and natural sciences could be advanced by a single case.

In addition, Erickson (1986) argued that because the general lies in the particular, what we learn in a particular case can be transferred to similar situations. Consequently, despite its limitations, a case study can further our insight into similar situations. In this study, the case study method allowed for an in-depth and detailed study of Civil technology teachers pedagogical capital when engaged with skills-based activities and so provides rich thick descriptions of the cases (Shuttleworth, 2008).

In overcoming the effects of a small sample size, rich thick descriptions were provided, data collated from the different instruments were juxtaposed to note convergences, divergences and patterns in terms of Civil Technology teachers' pedagogical capital strategies.

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