DIGITIZATION OF CIVIL TECHNOLOGY PRACTICAL LESSONS FOR PROJECT-BASED LEARNING AT EKURHULENI EAST, SOUTH AFRICA

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Abstract

In this modern education system, digitizing education at the secondary school level will be crucial to preparing learners for a world in which technology will become a valuable tool to make Civil Technology practical skills learning easy and more integrated into real-life projects. Digitization of practical lessons involves transferring traditional in-person hands-on practical demonstrations into digital formats using images and video recordings. However, following a teacher-led class, this teaching approach eases teachers' workload because learners will be using digital resources like smartphones and tablets to recall and practice the demonstrated practical skills; and that creates enough time for teachers to monitor and evaluate Project-Based Learning (PBL) activities in the classroom or workshop. Thus, using a case study research strategy, this study aimed to investigate whether digitization of practical lessons could assist in overcoming the challenge of limited time for PBL activities in schools. Purposive sampling was used to select twelve (12) Civil Technology teachers to participate in this study. Non-participant observation and semi-structured interview instruments were used as data-collection methods. Data collected was analysed using thematic analysis. The study found that Civil Technology teachers preferred the hands-on demonstration method and video recordings to conduct PBL. Furthermore, this study found that most Civil Technology teachers from Ekurhuleni East, South Africa do have Information and Communication Technology (ICT) knowledge and their schools have access to educational technologies like computers, smart boards, and internet coverage in their yards that may support digital teaching and learning. Therefore, this study recommends the digitization of Civil Technology practical lessons for effective teaching and convenience purposes.

Keywords: Digitization, practical lessons, project-based Learning, educational technologies, civil technology.

1 INTRODUCTION

The impact of the digital era in teaching and learning is rapidly becoming one of the most important and widely discussed phenomena in contemporary education policy all over the world especially in the developing countries [1]. To date, technology education is transforming because of digitization; thus, technology and vocational specializing schools are predisposed to these transitions. However, digitization of practical lessons in technology and vocational schools may have a significant influence on the effective teaching of hands-on practical skills subjects such as Civil Technology. Most education experts agree that, when properly used, the digital technologies hold great promise of improving the teaching and learning processes [2]. As a result, this circumstance has increased the demand for Civil Technology teachers who are hands-on, technologically savvy, and capable of integrating hands-on skills with education technologies to digitize practical lessons.

However, this study defines digitization of practical lessons as the process of converting traditional, in-person educational activities and materials into digital formats. Furthermore, the researcher emphasized that digitizing practical lessons in Civil Technology involves utilizing technology to create interactive and engaging learning experiences that can be accessed remotely through electronic devices such as smart-bords, computers, tablets, or smartphones. Moreover, digital technologies are electronic tools, systems, devices, and resources that generate, store, or process data [3]. Developments in digital technology in schools at Ekuhuleni East, South Africa as a means of teaching and learning practical skills can influence technology education teachers' ability to adapt to the 4.0 and 21st-century education system of skills acquisition. This study suggests that the Department of Basic Education (DBE) needs to provide technical subject teachers with Information and Communication Technology (ICT) skills development programs to enhance their teaching to the standard of the modern global education system. To improve the use of digital technology in South Africa, schools rapidly acquired Information and Communication Technology (ICT) hardware and infrastructure [4].

However, the utilization of digital technology resources for teaching and learning Civil Technology practical skills in the classroom or workshop may assist in bridging the gap between the limited instructional time for teaching and Project Based Learning (PBL) activities through Civil Technology Practical Assessment Task (PAT) from the Department of Basic Education (DBE) for learners' practical skills assessment purposes. According to [5], PBL refers to learning through experience and technology-supported active learning. For example, high school learners design a bridge for the future and learn advanced math concepts and engineering along the way. Thus, technical subject teachers like Civil Technology need to adapt to the outmost approach that enables quality time to conduct PBL effectively and easy through PAT like digitizing practical lessons. Although, most Civil Technology teachers conduct and complete the Civil Technology PAT simulations on time the given time through the PAT management plan infringes the quality time for PBL; also, that given teaching and learning time does not allow both demonstration and evaluation at the same time and that may cause the delay of completion of PAT and that can affect the preparation nor revision for National Senior Certificate (NSC) year-end final examination. Thus,[6], in their study titled "The Impact of Learning Time on Academic Achievement" in their study it show that quality time teaching and learning may help to improve student achievement. Furthermore, PBL in technical schools is affected by limited time to conduct many projects or simulations that are relevant to Civil Technology skills acquisition.

1.1 Aim of the study

This study aimed to investigate whether digitizing practical lessons could assist in overcoming the challenge of limited time for Project-Based Learning (PBL) of practical skills through Civil Technology Practical Assessment Task (PAT) in schools.

1.2 Research questions

The following research questions guided this study:

1 How do you perceive the role of digitizing practical lessons in overcoming time limitations for project-based learning?

2 How can digital technology be effectively integrated into project-based learning to enhance effective teaching through Practical Assessment Tasks (PAT)?

3 What are the emerging challenges when incorporating digital tools to enhance the efficiency of project-based learning in Civil Technology?

1.3 Objectives of the study

In line with the research questions, this study had the following objectives:

1 To investigate teachers' perceptions towards the role of digitizing practical lessons in overcoming time limitations within project-based learning environments.

2 To explore effective strategies for incorporating digital technology into practical lessons to improve project-based learning outcomes within the context of Practical Assessment Tasks (PATs).

3 To identify the emerging challenges faced when incorporating digital tools to enhance the efficiency of project-based learning in Civil Technology.

2 METHODOLOGY

In this study, a qualitative research approach was utilized to apply the techniques deemed appropriate for data generation [7]. The qualitative research approach is a comprehensive systematic inquiry into a social phenomenon in its natural environment [8, 9]. Furthermore, the qualitative research approach requires that researchers go to people, settings, and institutions to observe behavior in their natural locations [10]. However, this study employed a qualitative research approach to investigate whether digitizing practical lessons could assist in overcoming the challenge of limited time for Project-Based Learning (PBL) of practical skills through Civil Technology Practical Assessment Task (PAT) in schools. This research approach assisted the researcher in gaining a deeper understanding of how Civil Technology teachers conduct practical lessons and how limited time for Project-Based Learning affects the effective teaching of practical lessons for Civil Technology. Additionally, it assisted the researcher in understanding their perception of the digitization of Civil Technology practical lessons for project-based learning. Therefore, visits were made to the schools offering Civil Technology and the teachers

were observed to see how they utilized digital resources in their practical lessons. Additionally, the researcher had an opportunity to speak objectively and engage with teachers and learners of Civil Technology in their workshops and classrooms. The study aimed to investigate whether digitizing practical lessons could assist in overcoming the challenge of limited time for Project-Based Learning (PBL) of practical skills through Civil Technology Practical Assessment Task (PAT) in schools. Thus, the visitation to schools made it easy to explore their opinions and views about this phenomenon.

Population refers to the entire group or set of individuals, objects, or events that possess specific characteristics and are of interest to the [11]. Hence, the study population was in the Ekurhuleni East, Gauteng Province of South Africa. The district consists of 21 schools that offer Civil Technology subjects. However, the researcher selected teachers from all Civil Technology teachers disciplines namely Civil Services, Construction, and Woodworking together with all grades from grade ten (10) to twelve (12). Ekurhuleni East was chosen as the research setting because it was the researcher's previous workplace in one of the secondary schools specializing in Civil Technology. This afforded the researcher some level of convenience regarding data collection. Purposive sampling was adopted, and it assisted in identifying and selecting the twelve (12) Civil Technology teachers from Ekurhuleni East from the Gauteng Province, South Africa. According to [12], purposive sampling is a form of non-probability sampling in which decisions concerning the individuals to be included in the sample are taken by the researcher, based upon a variety of criteria which may include specialist knowledge of the research issue, or capacity and willingness to participate in the research. However, the reasons for adopting a purposive strategy are based on the assumption that, given the aims and objectives of the study, specific kinds of people may hold different and important views about the ideas and issues in question and therefore need to be included in the sample [13-15]. However, Civil Technology teachers (participants) were selected based on the certainty that participants possess real experiences and intimate knowledge about the phenomenon that is studied.

According to [16] data collection techniques refer to the techniques used to systematically collect data about objects of the study, including people and the setting where the data will be collected. Data collection as a main stage in research can overshadow the quality of achieving results by decreasing the possible errors which may occur during a research project [17]. [18] adds that it is crucial that data collection instruments should not limit the participants' views and that variation of data leads to greater validity. Thus, the research data collection instruments used in this study were non-participant observation and semi-structured interviews as data collection tools. The researcher was able to get qualitative data thanks to these instruments, which implies that the perspectives of participants and the information gathered from them were not constrained.

2.1 Non-participant observation

Non-participant Observation is a research technique where the researcher observes subjects without actively participating in the situation under study. However, this approach involves watching the subjects with their knowledge but without taking an active role in the observed activities. Furthermore, non-participant observation is significant in the sense that it grants researchers first-hand and direct exposure to the subject of an investigation by enabling them to generate comprehensive details of the events, environment, interactions, and participants' experiences [19]. Nevertheless, in this study non-participant observation was employed to observe how Civil Technology teachers are conducting practical lessons in their workshops. Non-participant observation was used with the intention of responding to the second study question, *"How can digital technology be effectively integrated into project-based learning to enhance effective teaching through Practical Assessment Tasks (PAT)?"*. As a result, the researcher observed Civil Technology teachers conducting their practical lessons. Hence, the observation schedule was set up so that comments could be made on the time management expertise of the teachers as they are using the PAT Management Plan (PMP) to keep on track of the completion dates of those specific simulations.

2.2 Semi-structured interviews

A semi-structured interview is a data collection method that involves asking participants a set of open-ended questions and following them up with probe questions to explore further their response and the topic of interest [20]. Furthermore, Semi-structured interviews in qualitative research are a blend of structured and unstructured interviews in that some questions are predetermined while others are not [21]. Also, [22] postulates that participants are interviewed to find out from them things we cannot observe directly, such as feelings, experiences, thoughts, attitudes, emotions, intentions and perceptions of participants. In this study the researcher used semi-structured interviews to collect new

data and explore participants' thoughts and beliefs about digitization of Civil Technology practical lessons for project-based learning. According to [23], a strong understanding between the interviewer and the interviewee should therefore be given priority. This will facilitate the building of relationships with research participants and encourage in-depth reflection and sharing [24]. Thus, in order to better understand the perspectives of teachers on digitizing Civil Technology practical lessons to enhance effective teaching, this study employed semi-structured interviews. The interviews lasted roughly twenty minutes (20) on average, and there were not any disturbances made by learners, teachers and other coworkers in the site of the interview. However, semi-structured interviews were used with the intention of responding to the first *"How do you perceive the role of digitizing practical lessons in overcoming time limitations for project-based learning?"* and the third "What are the emerging challenges when incorporating digital tools to enhance the efficiency of project-based learning in Civil Technology?" research questions. Nonetheless, in response to these two (2) research questions, teachers specializing in Civil Technology were given the opportunity to provide their experiences and thoughts about how the digitization of practical lessons might influence effective teaching and learning in schools.

3   RESULTS

This research section presents empirical findings and their interpretation from data analysis for the study's three research questions. Furthermore, Table 1. presents the biographical data of the participants (Civil Technology teachers) in order to create a profile of them. Biographical details provide qualitative research more context, depth, and subtlety. Thus, by providing a detailed biography of the study participants, researcher allow other scholars to evaluate the validity of their findings and replicate their studies if desired. It is important to highlight that all (teachers) held teaching qualifications. Below, is the summary of participants' biographical information displayed on Table 1.

Table 1. Summary of Participants' Biographical Information

Information:	Gender		Age group		Required qualification available?	Civil Technology subject specialisation	Number of years teaching the subject
	Male	Female	20 – 45 years	45 - 55+ years	At least Bachelor of Education (B. Ed)	Construction Woodworking Civil Services	03 – 05+ years
Teacher(s)	08	04	07	05	12	Construction- 06 Woodworking- 04 Civil Services- 02	All the participants are +5 years experienced.

3.1   Research question one (1) findings and discussion

How do you perceive the role of digitizing practical lessons in overcoming time limitations for project-based learning? Therefore, semi-structured interviews were the main method used to address this research issue, and thematic analysis was used to examine the empirical data. Civil Technology teachers were presented with open-ended interview questions to provide their ideas and perspectives on how to use digital tools to improve the efficiency of teaching and learning Civil technology practical lessons. Thus, the researcher collected and analysed data using the flowing themes:

– **Enhanced Accessibility**
– **Scalability and Efficiency**

Below is a thorough explanation of each of the previously stated emerging themes.

3.1.1   Theme one (1): enhanced accessibility

According to [25] digital resources allow learners to access practical lessons at their convenience, enabling them to learn at their own pace and schedule. However, this flexibility is particularly beneficial for Project-Based Learning, where learners may need additional time to grasp complex concepts or complete hands-on tasks. Furthermore, the participants mentioned that by digitizing practical lessons, teachers can make learning materials available around the instructional period, breaking free from the constrains of the traditional classroom hours. Moreover, this accessibility empowers learners to practice

their hands-on skills projects whenever they are ready, fostering continuous learning beyond the confines of the physical classroom. Therefore, each Civil Technology teacher's reporting is organized according to the following sequential categories:

TEACHER A:

"It will assist the new graduate or appointed Civil Technology teachers who are not yet familiar with teaching and managing of PAT in schools to master the subject hands-on skills on their own pace"

TEACHER B:

"It can assist us as teachers to have varied project innovations"

TEACHER C, F, H AND J:

The response of the above-mentioned participants was similar where all mentioned that it will enhance their PAT management skills and that can allow them to complete PAT earlier

TEACHER D:

"Digital lessons can help reduce the time used for demonstrations and help simplify the practical assessment task in a short period"

TEACHER E:

"It can create opportunities for learners to work together, share ideas, and give feedback to each other. One can use various tools, such as online forums, chats, blogs, and podcasts, to facilitate communication and collaboration among learners"

TEACHER G, I AND K:

Also, the response from these three participants was similar, the participants mentioned that digitizing practical lessons assist those leaners with special needs to learn on the pace and have a chance for consultations from their teachers.

TEACHER L:

"Digitization of Civil Technology practical skills will assist us as teachers to deliver and acquire the quality results from our learners at the end of the lessons because as a teacher now I can be able to monitor and evaluate their PAT while my learners are working on their own in presence"

3.1.2 Theme two (2): scalability and efficiency

Beyond the limitations of physical classrooms, teachers may interact with more learners through digital platforms [26]. Therefore, this scalability will enable more Civil Technology teachers to teach and evaluate Project-Based Learning initiatives, promoting inclusivity and diversity in educational settings. Furthermore, digitized practical lessons can help streamline the learning process by providing clear instructions, resources, and tools in one centralized location. This efficiency may save time for both teachers and learners, allowing them to focus on the core objectives of project-based learning without being hindered by logistical constraints. Therefore, each Civil Technology teacher's reporting is organized according to the following sequential categories:

TEACHER A – L:

In this instance, the common response visual was the centre of every participant's reaction. As a result, the researcher chose to compile all of the responses into a single version. The participants thought that it will be a good decision if the Department of Basic Education (DBE) can permit them to have a digitization of practical lessons as a choice for conducting Civil Technology project-based lessons. The participants believe that such actions may influence effective teaching and learning because they can be able to acquire learners with adequate Civil Technology hands-on skills. Furthermore, they recommended streamlining practical lessons because they believe that learners can learn on their own and they can also be able to evaluate and supervise their learners in the workshop after skills demonstration using either video assistance teaching instead of physical demonstration which consume more instructional period of the school day.

3.2 Research question two (2) findings and discussion

How can digital technology be effectively integrated into project-based learning to enhance effective teaching through Practical Assessment Tasks (PAT)? Thus, the primary data collection tool for this

research question was non-participant observation. Civil Technology teachers were observed conducting their practical lessons to find a supporting data for their views and concerns of limited instructional time they can support Project-Based Learning. Furthermore, only a few participants who practiced digital teaching using their smart boards and cell phones in the workshop. Therefore, in this study the researcher observed the following themes:

– **Preparation for the real-life work**
– **Creativity**

Below is a thorough explanation of each of the previously stated emerging themes.

3.2.1 Theme one (1): preparation for the future workforce

As the world becomes increasingly digitized, it is essential that learners learn how to use digital technologies effectively in the classroom so they are prepared for the future workforce. Therefore, integrating digital technology into PBL not only helps learners develop Civil Technology practical skills and essential skills like collaboration, problem-solving, critical thinking, and communication but also prepares them for careers where technological literacy is a necessity rather than an option. Therefore, each Civil Technology teacher's reporting is organized according to the following sequential categories:

TEACHER A, B, D, H AND I, J, L:

These above-mentioned teachers were observed conducting practical lessons. Furthermore, these participants were using traditional physical hands-on demonstration method when conducting Civil Technology simulations through PAT. However, the participants were observed only demonstrating skills and they never managed to evaluate their lessons after. The observation session was scheduled for not more then fifty minutes for all the participants. But it was unfortunate to observe that Civil Technology subjects' periods were ending while a least has been done and that does infringe learners and opportunity to be prepared for real life work.

TEACHER C, E, F, G AND K:

In this case, these were the only group that were observed utilizing digital tools when conducting Civil Technology practical lessons. The researcher observed the participants sharing the links and videos with the learners in the workshop. Furthermore, this seem so ease because at the end of the period learners having something done. Also, the participants were observed moving around the workshop conducting supervision when learners needed assistance. Also, the participants were observed demonstrating hands-on skills for learners. However, teacher K was observed preparing the classroom setting by connecting the overhead projector and he further allowed learners to settle down and the participant played the video while demonstrating the real-life simulation. This observation brought in a sense of allowing the learners in to real life activities for a future benefit where all the graduates walk out with adequate skills and real-life experience of the civil engineering world.

3.2.2 Theme two (2): creativity

TEACHER A – L:

In this case, the main purpose of this observation was to take scrutiny of this theme (creativity) when the participants were demonstrating Civil Technology practical lessons either digital or traditional way of teaching practical lessons which is physical hands-on demonstration. However, all the participants including those who used digital technology resources were observed providing endless opportunities for creativity in PBL projects through PAT during the observation session in schools. Therefore, this prove that if an integration digital technology with technical subjects can be employed from the secondary school level, this can result in to a fruitful country with high technology skills and artisanship.

3.3 Research question three (3) findings and discussion

What are the emerging challenges when incorporating digital tools to enhance the efficiency of project-based learning in Civil Technology? Thus, semi-structured interviews were employed to address this research issue, and thematic analysis was used to analyse data collected. Moreover, the participants were presented with open-ended interview questions to provide their thoughts and experiences concerning the emerging challenges when incorporating digital tools to enhance the efficiency of project-based learning in Civil Technology. Therefore, the data collected and analysed using the following themes as the guideline:

– **Technological Infrastructure challenges**
  – **Learner Engagement and Motivation**

Below is a thorough explanation of each of the previously stated emerging themes.

3.3.1 Theme one (1): technological infrastructure

Technological infrastructure challenges are one of the primary themes that may emerge when analysing the challenges of incorporating digital tools in project-based learning in Civil Technology. Previously, a number scholars have found out that technology education institutions have been suffering from the poor instructional settings that allow technical subjects to take place effectively. However, this study while the research was investigating the challenges that emerge when incorporating digital tools in PBL in Civil Technology. Based on the participants' responses, the researcher deduced that technical infrastructure is a recurring theme. This subject also includes concerns about the availability and reliability of technology infrastructure, including things like having access to computers and laptops, smart boards, high-speed internet, and other technical support resources. Therefore, each Civil Technology teacher's reporting is organized according to the following sequential categories:

TEACHER A:

"Where school are based on remote areas/ rural area where network is still a problem/challenge to use online or use the phone can be a challenge to such learners"

TEACHER B:

"My school cannot afford digital tools as yet. I think if we were to have them, a lot of time will be saved since practical lessons are factored in the current school time table that provide less time for them"

TEACHER C:

"Slow speed of computers, signal problem in Internet, virus threat, poor working condition of computers, load shedding, and lack of access of Internet. These can delay the implementation of the lessons and leads to tasks not being completed"

TEACHER D:

"There are not many digital tools which are for Civil Technology that educators can get and that makes it hard to be able to implement them"

TEACHER E:

"Lack of resources is the major challenge in implementing digital lessons and the traditional method of teaching consumes more time for practical lessons"

TEACHER F:

"Poor maintenance of the smart boards and electrical components in my school may disturb all that"

TEACHER G:

"I don't have smart boards to project videos in my school"

TEACHER H:

"Sir, I am old and there are no digital skills training, the department only provided the subjects' hands-on skills not ICT skills"

TEACHER I:

"The smart boards in my school are no longer working"

TEACHER J:

"Limited internet coverage, so it does not reach my classroom or workshop where there is a smart board, my laptop and overhead projector"

TEACHER K:

"My workshop does not have the smart board"

TEACHER L:

"If they can maintain all these electronical components like smart board and boost the internet coverage"

3.3.2   Theme two (2): learner engagement and motivation

Learner engagement and motivation are crucial factors in project-based learning. Hence this type of learning method is learner centred. In this study, the participants revealed a worrisome concerning the and motivation of learners' interest into Civil Technology hands-on artisanship. However, using semi-structured interviews the responses were received from the participants and a common concern was noticed which the researcher noted it as the theme. Thus, the theme of learner engagement and motivation may involve challenges related to maintaining learner interest, providing meaningful learning experiences through digital tools, and fostering collaboration among learners in a virtual environment. Therefore, each Civil Technology teacher's responses were analysed and the study found that the responses were all concern around the common matter; therefore, data was combined into one and organized as follow:

TEACHER A – L:

In this section the participants responded differently but under a common concern. The majority of the participants mentioned that they may find it hard to engage all the learners into when integrating digital tools with practical lessons. This maybe be caused by poor home backgrounds of other learners hence this method will require at least the use of smartphones, tablets and computers and they cannot afford those resources. Furthermore, Teacher C also mentioned that it may be difficult to engage learners in digital teaching in schools because her school policy state that no cell phones are allowed in the school premises and the Gauteng Department of Education (GDE) has long stopped providing tablets for learners use in schools. Also, Teacher J mentioned that it may be difficult to motivate learners because in some schools including where the participant is working, they do not give learners proper orientation of these technical subjects like Civil Technology; this led into bad interest from learners because the subject was not their first-choice subject but it was given because the learner did not do well on mathematics and science subjects. Furthermore, Teacher H also mentioned that learners are demotivated because of their financial situations from home, where they cannot be able to buy digital resources on their own since the GDE is no longer providing learners with such.

4   CONCLUSIONS

Hence the aim of this study was to investigate whether digitizing practical lessons could assist in overcoming the challenge of limited time for Project-Based Learning (PBL) of practical skills through Civil Technology Practical Assessment Task (PAT) in schools. This study conclude that digitization of Civil Technology practical lessons is possible from the secondary school level at Ekurhuleni East, Gauteng Province of South Africa, and may influence effective teaching and learning of the PBL through PAT. However, this study recommends the digitization of Civil Technology practical lessons for effective teaching and convenience purposes. Additionally, this study recommends digitizing hands-on Civil Technology practical lessons because using digital tools in the classroom can be the most beneficial thing for teachers and learners to do as it relates to developing their creative thinking and may provide good outcomes like acquiring a large number of graduates with adequate Civil Technology craftsmanship. In this study data was collected using two (2) data collection tools namely; non-participant observation and semi-structured interviews. However, post-data collection thematic analysis was used and those themes served as the guidelines to of the study research. During non-participant observation the participants were observed conducting practical lessons using digital tools. Thus, such findings support the suggestions and recommendations of this research study. Hence, this is also underlined by the fact that the use of video recordings is already widely recognized within the modern education system [27]. It is also evident from the review of the collected data that digital tools can be used to assist teachers with PAT management skills to championing the issue of limited time for PBL through PAT in schools. The identified themes can inspire further research and practice on the use of digital tools to support technical subject teachers like Civil technology for effective teaching and learning of practical lessons using digital tools. Moreover, the researcher is will ensure further related studies are conducted to build on the themes and identify further opportunities and solutions.

ACKNOWLEDGEMENTS

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