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Views and Experiences of Pre-Service Science Teachers on the Use of Technology in Teaching and Learning of Electric Concepts

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Abstract

The purpose of the study was to explore pre-service science teachers' views and experiences on the use of technology in teaching and learning of electric concepts. The study sample consisted of six pre-service science teachers enrolled in Physical Science level 1 at a university of technology in South Africa, who aspire to be Physical Science teachers, and whose curriculum consists of electricity. The study adopted a case study research design embedded within the qualitative research method. Data for the study was collected voluntarily from participants in alignment with the convenience sampling technique. The results of the study indicate the need for educators to have technology integration strategies to accommodate learners with different learning abilities and to be able to do virtual experiments as some schools lack equipment needed to conduct experiments. Moreover, pre-service science teachers recommend the use of technology integration because, students can benefit from enhanced engagement, diverse perspectives, flexibility, and reinforcement of learning. In addition, technology integration is cheaper, safer, and more convenient but it requires training.

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INTRODUCTION

The education system transforms as we shift from one industrial to another (Kim, Raza & Seidman, 2019; Ndibalema, 2014). Industrial Revolution refers to modifying resources and methods of doing work in industries (Liao *et al.*, 2018). How industries operate influences the education system, politics, the development of the economy, and international relations (Philbeck & Davis, 2019). This means as we move from one industrial revolution to another, the system of teaching is compelled to change and make use of the current technology to meet the demands of industries (Azmi *et al.*, 2018; Kehdinga & Fomunyam, 2019; Liao *et al.*, 2018). Therefore, the teaching strategies have to be revised to make learning and teaching interesting to the children of this century (Ally, 2019)learning will be adaptive and individualized to meet the needs of individual learners. This is possible because of emerging technology, artificial intelligence, and the internet of things. This study is making significant contribution to future education by identifying forces that are shaping education and developing a competency profile for the digital teacher of the future. The research conducted focus groups and interviews with education experts from six countries to identify the forces shaping education in the future and the competencies required by the digital teacher to function effectively. The Competency Profile for the Digital Teacher (CPDT.

The use of technology in the classroom is mandatory in the 21st century, especially in preparing the student teachers who will teach in the era of 4IR (Ally, 2019; Fong *et al.*, 2019; Olika *et al.*, 2019)South Africa. Data was collected by means of individual interviews. Data were analyzed manually using patterns, categories, codes and themes. Findings revealed that there was evidence of inadequate digital technology teacher professional development programs (DTTPDPs. Teachers who are inadequate in using technology negatively affect the learner's performance as they cannot explain the concepts explained through technology integration (Mpungose, 2020)despite the attempt at introducing the new 4IR curriculum into schools. Consequently, this qualitative interpretive case study explored student teachers' knowledge in the teaching of CAPS subjects. The study purposively selected thirty-one student teachers from a South African university who were conducting teaching practice; they were also conveniently co-opted because they were fourth years, conducting teaching practice in three different schools. A technological, pedagogical and content knowledge (TPACK. This means the technology does not only help teachers to do experiments but to demonstrate and explain abstract concepts that involve movements such as the movement of charges.

Previous research on integrating digital technology by Olika *et al.* (2019) found that teachers struggle to use technology in the classroom because they lack confidence, some they are not motivated, and there is no continuous training. The study done by Darmawan et al., (2020) recommends the use of quizzes as an assessment tool but this also requires ongoing training. Although there are many ways of integrating technology, many researchers focused on one or two methods looking at how the methods impact students' achievement with limited research on how pre-service science teachers perceive the use of various methods of integrating technology particularly to learn electric concepts. The views of pre-service science teachers are important because they help teachers training institutions to improve the way they train prospective teachers, they also determine the comfortability of pre-service science teachers on the use of technology. Moreover, researchers also get a chance to probe the projected obstacles that may hinder implementation and devise other alternatives.

The objective of this study was to outline perspectives of pre-service science teachers on the use of technology in teaching electricity concepts because it was found that learners at secondary school are not doing well in electric concepts. Their performance in the past six years is indicated in figure 1 ((Education, 2020).

Pre-service science teachers (PSTs) views and experiences (VEs) provide an overview of the technological methods they may employ in TLEC and the rationale. These VEs then lead to assumptions about how a specific technology mode should be used to improve learning. Subsequently, the mode of teaching chosen has an impact on the understanding of concepts. Teachers who are positive about the use of technology in teaching and learning are more likely to use it in their classrooms (Luik et al., 2018).

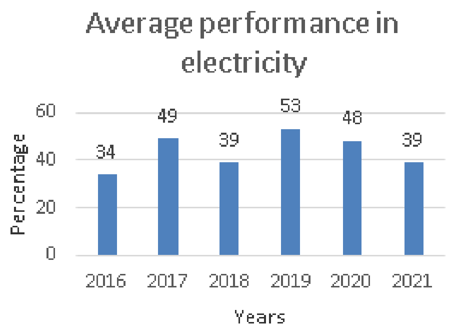

Figure 1. Average performance in electricity

Research has been made by different researchers to help students assimilate electric concepts to improve their performance. Different teaching pedagogies such as analogies, coding of electric circuit, 4MAT teaching methods underpinned by the Theory of Constructivism (Vygotsky: 1978) has been used (Alanazi, 2020; Kırıkkaya & Başaran, 2019; Rankhumise & Imenda, 2014; Yasin et al., 2018). In a similar approach but more plausible, this study sought to determine pre-service science teachers' views and experiences with teaching with technology because their experiences are deemed vital for broader comprehension of the pros and cons of integrating technology into the classroom (Dukes, 2020). The findings of this inquiry may also aid in determining how teachers should be trained in the use of technology to explain abstract concepts in electricity.

The empirical setting of the data collection was face-to-face structured interviews. Their responses were coded into themes based on how they viewed and experienced these three methods of integration i.e. YouTube, Mgames, and PhET simulations. The study employed a data-driven approach to understand individual reasons for preferring or not preferring each method for his or her own teaching practice.

2. Theoretical Framework

This study is grounded on the Socio-constructivism theory (Vygotsky, 1978). According to the Social-construction theory, knowledge is acquired based on individual experiences in relation to parameters such as culture, society, or historical context (Kayzouri et al., 2022; Khaliliaqdam, 2014)a learner has the potential to progress from their actual developmental level to their potential developmental level via scaffolding that occurs during interaction with superior others. This case study was conducted based on Vygotsky's (1978. This theory is aligned with relativism where people have different perspectives on phenomena based on their experiences (Fernández et al., 2021). It is believed that using technology improves learning (Fong et al., 2019; Olika et al., 2019)South Africa. Data was collected by means of individual interviews. Data were analyzed manually using patterns, categories, codes and themes. Findings revealed that there was evidence of inadequate digital technology teacher professional development programs (DTTPDPs. Ontologically, depending on how teachers and students use technology, it may enhance learning in different ways. For example, the Mgames app was designed to help students to understand electrical concepts, but in an Indonesian study, Mgames helped students develop positive attitudes toward engineering-related studies rather than improving their STEM literacy. This was due to the amount of time spent using the app. The same app was used in Europe in a different study, and students' comprehension of concepts improved (Kırıkkaya & Başaran, 2019).

According to Gustafsson (2013), the use of YouTube in learning electric concepts leads to different attitudes and views among students, which are based on epistemic relativism. Pre-service teachers' pedagogical methods are influenced by their beliefs and experiences with the modes used on them or by them during their teaching practice.

The study aimed to answer the following research question. What are the views and experiences of pre-service science teachers on the use of technology in teaching and learning of electric concepts?

METHOD

This study adopted a qualitative research design to investigate the views and experiences of pre-service science teachers on the use of technology in teaching and learning of electric concepts. According to (Levitt et al., 2018), a qualitative research design focus on process , implementation, development, emphasis on individual outcomes, and in-depth information. This study investigates implementation of technology and seek to provide an in-depth understanding of how pre-service teachers perceive integration of technology in TLEC. This forms a case of one university of technology. A case study is formed when the study focus in a specific group or individual and the research questions are directed for that group (Morgan et al., 2017). A group of student teachers from a university of technology intending to teach physical science at secondary school forms the case.

Pre-service science teachers doing physics level one in the Department of Education were formally invited to attend interviews to perceive their views and experiences on technology integration in TLEC. Out of 69 students enrolled for Physics level one in 2022, six pre-science teachers were interested in participating in this study, which formed the sample size of this study. All students received formal letters to participate after the university ethics committee granted the researcher permission to collect data from the students. This group was selected because they aspired to teach Physical Sciences where electric concepts form a chapter and they had experience of using technology in learning of electric concepts. Due to proximity and accessibility to the university, since the researcher was working as a laboratory technician in the institution, convenient sampling technique was suitable for this study (Etikan, 2016, 2017; Taherdoost, 2018). The names used in this study are not the real names of the participants, but rather pseudonyms.

Data collection and analysis

Data collection is a process where specific methods are used by researchers to collect data in order to answer the research question (Creswell et al., 2007; Levitt et al., 2018). The data was collected through face-to-face structured interviews in September 2022. The interviews were recorded using Microsoft teams because Microsoft teams keeps the data up to 3629 days. Volunteered pre-service science teachers were interviewed on how they perceive the use of technology in TLEC. The empirical process of the research was through voice recording and structured questioning. The researcher was the interviewer, recorder and the transcriber of the interviews (McGrath et al., 2019). Data-driven approach was used to develop codes and themes inductively. This enabled the researcher to achieve better understanding of individual perception for each type of technology tool they used. All participants answered the same questions asked in the same order.

RESULT AND DISCUSSION

Pre-service science teachers (PSSTs) who volunteer to say their views and experiences about technology integration in TLEC attended face-to-face structured interviews. All participants were formally invited to attend interviews. The researcher wanted to interview as many participants as possible until she reaches saturation. Interviews took place in the laboratory, one week before the end of September 2022, which was the end of the third term. The researcher interviewed seven participants, two females and five males. Interviews were recorded using Microsoft teams which keeps the data for more than 3625 days. Prior the main questions about the views and experiences participants were interviewed about their background and how they learned electric concepts in their secondary schools their brief responses are tabulated in table 1

The interviewees ages ranged between 20- 29. Three of the participants did electric experiments, but two did them in the form of projects, meaning that they were asked to build circuits at home with the help of their relatives, while one did them in the school laboratory. Only one participant had excess to the laboratory, six did not have laboratories in their schools. However, they used YouTube for clarification of some of the concepts. None of them used PhET simulations and Mgames in their secondary school life. These participants represented five provinces out of nine provinces in South Africa.

PSSTs teachers recommend the use of technology because even the schools where they visited for teaching practice did not have functioning laboratories, some of them they were given this chapter to teach. Prior-interviews these PSSTs attended training on how to use YouTube, PhET simulations and Mgames to learn electric concepts. Their views and experiences were based on these three, as they did not integrate technology in their secondary schools. Assigning codes to words and phrases in each response helps capture what the response is about which, in

Table 1. Background of interviewees

Name	Age	Gender	Province	Access to the Lab.	Tech used
Johnny Walker	24	M	Limpopo	No	None
Good hope	23	F	KZN	No	None
Lady B	27	F	Gauteng	No	None
Njister	20	M	Gauteng	No	YouTube
Khalifa	21	M	Gauteng	No	YouTube
Thibos	29	M	Mpumalanga	Yes	YouTube
Mashesha SJB	29	M	Limpopo	No	YouTube

turn, helps you better analyse and summarise the results of the entire interview. To answer question about their views, their responses are quoted below, and they form the first theme:

Theme 1: Views

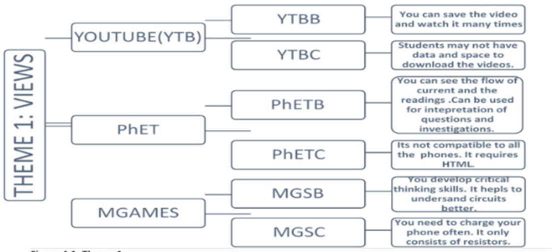

Figure 4.1: Theme 1

Figure 2. Views

The PSSTs views formed a theme and coded into benefits and challenges. In the diagram below, YTBB is the code for benefits of using YouTube; YTBC is the code for challenges of using YouTube. MSGB means benefits of using Mgames, and MSGC means the challenges foreseen by pre-science teachers on the use of Mgames. PhETB, PhETC are the codes assigned to benefits and challenges of using PhET simulations respectively.

Goodhope: *The use of technology saves time. Doing simulations and playing games helps you to acquire new knowledge.*
Researcher: *Which knowledge did you acquire?*
Goodhope: *For example, I did not know how to answer the question that required us to explain the difference between removing a resistor and replacing it. However, with simulations, I was able to understand what is happening in the circuit and in the test, I did not guess as I used to.*
For me, Mgames was the best because I like games. There more I fail the more I try. The more I pass the more I want to play and the more I learn.
Researcher: What challenges do you foresee when using these methods in class?
Goodhope: Most learners might not have cellphones. Network can also be a problem and sometimes wife' does not work.
Jonny walker: All schools need to be provided with technology tools so that learners can have access to these fascinating methods of learning. In the school where I went, there was no technology. I foresee a challenge of network. Few students had smartphones because I came from previously disadvantaged background. I would YouTube for demonstration but I prefer PhET simulations because you do the same experiments and learners will not fear to break the apparatus. As the teacher, you do not have to move around from class to class with apparatus.
Mashesha SB: Generally, I think our education is more of textbook. People will have to move from textbook. I think I will lose time, trying to teach them how to use PhET. Secondly, I will have a challenge of students who do not have the resources and grouping students may disadvantage those who do not have the gadgets, as they will not be doing the practicals.
Khalifa: I like technology, because there is no risk of injuries, you do not need to carry out apparatus. Nevertheless, it requires everyone to have a smartphone because you learn better on your own phone. In my classroom, I would use all the methods but not YouTube. Many students get distracted when watching a video. Some people's voices on the videos are boring. I do not see any challenges if they do not have phones they ask from their relatives and I can project the activities on the screen. However, I prefer PhET because; it shows every reaction in the circuit you feel like you are in the real lab.
Lady B: It makes things easier, its accessible, each learner get a chance to do the simulation. Considering new ways of learning, they are good for memory retention. They can access the games anywhere and anytime. Well, we are coming from different backgrounds, so not every learner has the equipment to use technology. Not unless the school can provide. I would choose Mgames because; it's fun, educational and it stimulate creative thinking. The comments that are there when you pass the level makes you feel proud of yourself.
Njister: I think it's good and bad. As I said earlier, it makes things easier and saves time. You get all the apparatus online. However, you cannot feel the heat, sometimes technology does not work. Nevertheless, I recommend the use of technology because it has more advantages than disadvantages. You can see the brightness of the bulbs clear than when you are using physical apparatus. For me PhET simulation was the best. However, technology is not for everyone. Network might be a challenge.

Thibos: It is important to use technology because it saves time. Technology is convenient because most students are familiar with technology. I did not struggle to use any method we used in class. The challenge I foresee is the availability of gadgets to all students. Another challenge might be data and all these methods require a projector to display the activities. Nevertheless, in my classroom I would use PhET simulations.

To answer the question of how they perceive the use of technology, their responses are grouped per technology used. Two participants mentioned that students were not allowed to bring cell phones to schools.

Theme 2: Experiences

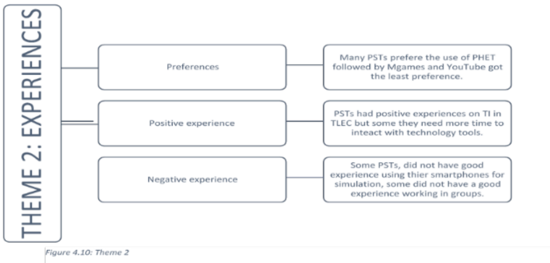

Figure 3. Experiences

Goodhope: (i) *YouTube makes things easier, it is better to watch than to read a textbook. You get a lot of information while you are watching and it is easy to understand.*
(ii) With PhET simulations you are able to see how you supposed to connect parallel resistors and how the circuit looks like when the switch is open and when it is closed.
(iii)Mgames also assist because the more you play the game the more you understand how the circuits are connected. As we kept playing, we understood how the circuits should be connected.
Johhy Walker: (i) YouTube is very helpful for me. It provides information.
Researcher: Information like what?
Jonny Walker: Like watching how to do an experiment
(ii) For now, its sticky tricky connections, I need more time to use PhET simulation. Group members simulated the experiment.
(iii) I did not navigate the phone. I have a phobia of technology and other group members were fast so I preferred to watch them. Mgames, looks like it makes things easier for us as teachers to help students understand the electricity chapter.
Mashesha SJB: I can use PhET only. However, its better when you are using the computer than a phone. It was my first time to see the flow of current and to use a resistor.
(ii) YouTube, No, I will not use it in my classroom. Because it has a lot of distraction, the experience will be less. The form of learning it is more or less like the theory because they are not the ones connecting the apparatus. YouTube is more or less like the textbook.
Lady B: (i) It helps to prepare for lessons, it is also good for revision and you can learn new content
(ii) My experience was that, I could connect a virtual circuit without any physical apparatus in front of me.
Researcher: How did you feel about that?
Lady B: I was excited.
Researcher: Can you use it in your classroom as the teacher?
Lady B: Yes, I can use it. PhET is very accessible and we are a technology generation."
(iii) I really liked the fact that you play around with circuits. It's fun at the same you learn. I think its an innovative way of learning because books are boring.
Njister: (i) The use of YouTube only is not enough because its better when you do the experiment yourself so that you know how to connect. Sometimes the reading come out different when you connect the circuit yourself. YouTube is as if you are reading a textbook because you cannot ask questions.
(ii) PhET makes things easy, for example if I am conducting experiment I would struggle to get the internal resistance whereas you can see it with PhET and you understand its meaning. With PhET simulations if you connect something wrong you can see the battery burning and you can see the readings and its easy to make changes. Unlike with physical apparatus when a bulb burns, it will take time for you to buy another one.
(iii) Truly speaking, I did not pay much attention with Mgames because we worked as groups. The class was overcrowded and it was hot. I relied on other peoples answers.
Researcher: Why did you rely to your group mates answers?
Njister: Because my phones battery was low.
Thibos: (i) YouTube is much appropriate; I can use it in my classroom as the teacher.
Researcher: How?
Thibos: To demonstrate something.
(ii) PhET simulations allows you to get the same data or readings you were supposed to get with physical apparatus. You get values of current, voltage etc.
(iii) Mgames helps you to understand how to draw and how to connect the circuit.
Khalifa: (i) I do not really like YouTube because of distractions by adverts and you cannot ask a question from the video.
(ii) It's much easier working with PhET. You can see how the current flows. It is much better when you do it as individual. You can make mistakes and learn from them.
(iii) The use of Mgames was the best experience. It helps with critical thinking. You have to think before you connect the circuit even before you do calculations. Some problems were challenging but I enjoyed the activities. Mgames helped us to understand circuits better.

YouTube: Some pre-science teachers who participated in this study do not recommend the use of YouTube in their classroom because it requires data or access to internet which is a challenge in previously disadvantaged families.

However, you can download the video and watch it as many times as you want. Hence, one sees the use of YouTube to help learners for revision. Another concern regarding YouTube is that learners cannot ask questions and they are forced to watch other peoples work rather than observing their own experiments and analyse their own data. Also, if they do not understand certain threshold concepts, they cannot ask questions since it is a recorded video

Mgames: It is convenient because it is easy to download the app and you need internet once, not every time you want to access the app. Learners can play the games anytime you want. Mgames helps you to understand the difference between series and parallel connection. However, it only focuses on resistors, there are no light bulbs and learners learn from their mistakes.

PhET Simulations: It provides similar results to hands-on activities. Moreover, learners even see the flow of charges and they get instant feedback Everytime they connect a devise. Learners not use it only for experiments but also for understanding questions. PhET allows them to connect any type of electric circuit. Some learners might not have gadgets to use PhET and PhET is user friendly in some cellphone, it is better on the laptop.

The results indicate that pre-service science teachers (PSTs), came from schools with no laboratories and therefore no means of doing experiments related to electricity. Through interviews, the researcher gained a deeper understanding of how PSSTs perceive the use of technology in teaching and learning of electric concepts (TLEC) based on their individual experiences. Their background influenced individual experiences, which is consistent with social constructivist theory. According to the social-constructivist theorist (Vygotsky, 1979), knowledge is acquired based on individual experiences concerning parameters such as culture, society, or historical context (Kayzouri et al., 2022; Khaliliaqdam, 2014)a learner has the potential to progress from their actual developmental level to their potential developmental level via scaffolding that occurs during interaction with superior others. This case study was conducted based on Vygotsky's (1978. This means PSTs' views were based on how they interacted with technology, considering their historical context. Due to the benefits associated with technology integration, the analysis indicated that they perceived technology integration (TI) positively. The pre-science teachers had positive experiences and they perceive the use of technology positively since they acquired new knowledge from the activities during intervention.

Many of them during interviews referred to these activities as the new information they had acquired. They recommended PhET simulation as the best method of learning electric concepts over the use of YouTube. This support the finding obtained in Haryadi & Pujiastuti (2020), where science teachers had positive perceptions on the use of PhET simulations because it allowed students to explore new concepts and improved students science concept skills. Moreover, PSTs recommended PhET simulations because it cannot only be used for experiments and demonstrations but also for understanding questions. One participant said, "PhET allows you to connect any type of electric circuit". However, they mentioned some challenges associated with the use of PhET simulation as one said,

"Some students might not have gadgets to use PhET and PhET is user friendly in some cell phones, it is better on the laptop".

This was a distinct finding as many studies did not find any gaps regarding the use of PhET simulations.

Goodhope's experience indicates self-motivation, which differs from the finding of the Olika *et al.* (2019)South Africa. Data was collected by means of individual interviews. Data were analyzed manually using patterns, categories, codes and themes. Findings revealed that there was evidence of inadequate digital technology teacher professional development programs (DTTPDPs study, where teachers needed some incentives to be motivated to learn with technology. Technology integration is also associated with an individual's attitude toward it. Thibos's experience concurs with Yuliati *et al.* (2018) and Yunzal, Jr. and Casinillo's (2020) findings because they found that technology is a good tool for conceptual understanding. Khalifa's experience indicates that interacting with the Mgames App was not easy, although it was fun, and he managed to understand the concepts better. This concurs with the enhancement stage of the SAMR model of Puentedura (2006). Based on the SAMR model, the textbook and the time to mark homework are replaced by the game with a learner-centred learning method (Aldosemani, 2019).

Furthermore, previous research indicates that regular classroom technology use motivates students to learn without the teacher's guidance (Kırıkkaya & Başaran, 2019). These findings further suggest that PSTs were able to learn on their own. Moreover, there were similar views amongst these PSTs views. These include that integrating technology is safe, saves time, and helps explain abstract concepts. Therefore, technology integration is economically friendly. However, despite the good things associated with integrating technology, they mentioned similar challenges in the previous research. These challenges include lacking infrastructure and networks in rural areas ((Mpungose, 2020b; Ndibalema, 2014; Olika et al., 2019)the paper provides a better understanding of ICT as a pedagogical tool. The development of this study was influenced by various concerns of educational stakeholders about the level of teachers' competence on the use of ICT as a pedagogical tool. The data collection methods involved questionnaire and interview. A total of 80 teachers, through random sampling in 10 schools were involved in this study at the first phase of data collection and 10 teachers were obtained through purposive sampling from 2 schools at the second phase. It was found that teachers have positive attitudes towards the use of ICT as a pedagogical tool but they did not integrate it in their teaching effectively. Also, low familiarity with ICT use as a pedagogical tool among teachers was found to be a problem. The use of ICT as a pedagogical tool in Tanzania seems to be a critical situation among teachers. The paper recommends further in-depth investigation on teachers' willingness, confidence, motivation, feeling, thinking, belief and the actual practices through classroom observations including larger samples. On the whole, the study's findings are seen to be of particular relevance to both teachers and the educational policy-makers in Tanzania. Background to the Research Problem The purpose of this study was to provide a deep understanding about ICT as a pedagogical tool. Within this broad aim, the study intended to explore teachers' attitudes on the use of ICT as a pedagogical tool. The study was triggered by various concerns from educational stakeholders that teachers are not aware of the potentials that technology offers in pedagogy (Mselle, 2012. According to Ndibalema's study (2014), teachers could not integrate technology because they did not have time to learn how to use it; they had to complete the syllabus, which hindered the use of technology in the classroom. In addition to these challenges, two PSSTs' views and experiences indicated a possibility that they might not use technology in their classroom. Their voices are quoted below.

Mashesha SJB*: "Generally, I think our education is more of a textbook. People will have to move from a textbook. I think I will lose time, trying to teach them how to use PhET. Secondly, I will have a challenge of students who do not have the resources, and grouping students may disadvantage those who do not have the gadgets, as they will not be doing the practicals".*

Johnny Walker*: "I did not navigate the phone. I have a phobia of technology and other group members were fast so I preferred to watch them. Mgames looks like it makes things easier for us as teachers to help students understand the electricity chapter".*

The analysis of these findings indicates the importance of training PSTs on technology integration while they are still at university. It is apparent that once-off training may not be enough as some PSTs need more time than others to interact with technology. In industry, training is not continuous as in teacher training institutions (Gleason, 2018). Pre-service science teachers' pedagogical methods are influenced by their beliefs and experiences with the modes they use or by them during their teaching practice (Atabek, 2019; Kazempour & Sadler, 2015; Luik et al., 2018). Moreover, positive perception does not imply that all students are comfortable using technology tools. One PST mentioned that "technology is not for everyone".

This means that when using technology for learning, teachers should be aware of learners who have a constrained zone of proximal development. As Johnny Walker mentioned above, that he recommends the use of PhET simulations, but he needs more time to interact with the simulations for him to assimilate the electric concepts. As a result, positive perception does not imply that all students are comfortable using technology tools. This is concurrent with the results obtained by (Ally, 2019; Kehdinga & Fomunyam, 2019), where pre-science teachers were competent in how to use technology but lacked pedagogical content knowledge. The results obtained in this study have similarities with other studies, in the sense that pre-science teachers perceived the use of technology positively.

CONCLUSION

The views and experiences of PSSTs indicated the need for ongoing training on technology integration. The Department of Basic Education should motivate experienced teachers to integrate technology because it is cheaper, convenient and safer. Views and experiences of PSSTs indicated that they can integrate the technology methods learned in this study. Many of them experienced PhET simulations and Mgames for their first time. Despite the challenges they foresee, they recommend the use of technology because it not for experiments only but also for understanding questions and concepts.

Therefore, participants were empowered both technically and professionally. Pre-science teachers were delighted to participate in this study because they were going to share new skills with other teachers in the field, and the knowledge and skills they acquire would help in the improvement of performance in this section. This study also influenced the training of student teachers on how to integrate technology into the teaching and learning of electricity concepts. Curriculum developers and all school stakeholders would benefit from the results of this study, as it explicitly explained how to use each method and the views of pre-science teachers who participated on interviews.

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