Physical science teachers' perspectives on professional development and use of digital technology

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Abstract: This paper examines physical science teachers' views and experiences on professional development and digital technology integration for teaching content specific. Using a qualitative ap-proach and case study design embedded in the technological pedagogical content knowledge (TPACK) model and concerns-based adoption model (CBAM), this article reports on how physi-cal science teachers from technologically resourced schools perceive their preparation to use technology during professional development. Four participants with more than three years teaching experience of physical science were selected for data collection. Data was collected through semi-structured interviews and was thematically analyzed. The key findings of the study indicate that inadequate digital technology professional development leads to teachers' unpreparedness which tremendously influences the extent of using technology for teaching in physical science content. The paper recommends the need for ongoing professional develop-ment of physical science teachers on the use of digital technology to teach specific content. Based on the existing literature, the principles of effective professional development can be used to narrow inequalities in developing countries such as Lesotho. The paper recommends future research to investigate the maximum effectiveness of technology integration in other subjects as to improve teaching and learning in developing countries such as Lesotho.

Keywords: Digital technology, Professional development, Technological pedagogical content knowledge (TPACK) model and concerns-based adoption model (CBAM).

1. Introduction

Promoting quality education through the professional development of teachers is a global focus on achieving quality education as it increases teachers' competence in delivering teaching in-struction (Gudmundsdottir & Hatlevik, 2018; Kohnke, 2021; Rafeeq & Ali, 2021). According to Mwangi and Khatete (2017) the need to enhance teachers' technological aptitude is high. This indicates that the quality of education delivered directly depends on the quality of the teacher. Warner et al. (2021) and UNESCO (2016) argued that technology alone cannot improve the quality of education; instead, effectively integrating technology with teaching content and ped-agogies can be of great support. Previous studies documented the effectiveness of teacher pro-fessional development on technology integration in education to include the provision of expo-sure and expertise to learners on the elements of 21st century thinking skills (Salleh et al., 2021; Yin-Chan et al., 2017; UNESCO, 2016). More importantly, the results from research pin-point that the adoption of technology in education fosters learners' motivation toward learning specific physical science content (Warner et al., 2021). Avisteva (2019) added that technology integration also enhances the instructional effectiveness, convenience and cost-effectiveness of the teaching process. Consequently, sustainable and quality professional development is inevi-tably a central component for enhancing quality education through technology integration (Ra-feeq & Ali, 2021).

The adoption of technology in education has been implemented without consideration of the personal beliefs, experiences and socio-cultural influence of teachers (Dlamini & Mbatha, 2018; Kohnke, 2021; Li, 2022). This proved a lack of sense of the concept, its dimensions and characteristics and the

holistic essence of technology integration. The quest for technology in education may display professional limitations such as lack of knowledge or competency in technology usage. Therefore, the proliferation of technology demands greater opportunities for teacher professional development toward technology integration. This scenario can be changed through the adoption of small communities who practice appropriate and relevant activities to explore new teaching methods and tools that transform beliefs toward digital technology inte-gration (Avisteva, 2019).

The perceived usefulness of technology and professional competency in its use influence teach-ers' uptake thereof. Additionally, it ensures teachers' confidence in digital technology integra-tion (Gudmundsdottir & Hatlevik, 2018; Li et al., 2019). Along with this finding, the Education Sector Strategic Plan (2016¬2026) urged the Ministry of Education and Training (MoET, 2016) in Lesotho to improve access to quality and equitable education through the p development of innovative skills. This suggests that teachers' training activities have to conceive of altering their beliefs by offering them opportunities to work with technologies. However, according to research, most teachers who have received training on digital technology still lack enough con-fidence in using digital technology into teaching specific content (Dlamini & Mbatha, 2018; Li et al., 2019; Mwangi & Khatete, 2017). This emphasizes that more focus is placed on the knowledge of computer skills and applications not considering the teacher's efficacy. Motivat-ed by these shortcomings, the present paper aims to explore physical science teachers' views regarding professional development and integration of digital technology.

Teacher's use of digital technology such as YouTube, WhatApp, internet assist in developing learners' innovative skills too. Lesotho has recently localized its curriculum as to continue with improvement of skills for learners. The Curriculum and Assessment Policy was developed to shift from a curriculum that was assessment-based and emphasized cognitive skills to a more process-oriented curriculum (Raselimo & Mahao, 2015). Like in other countries around the world, the argument articulated in the policy statement is that there was an education gap in the education system of Lesotho. To rectify this, the Lesotho Education Sector Strategic Plan (2016□2026) set goals, which include improving access to quality education and improving performance in science and mathematics at all levels of teaching and learning. The plan thus properly prepares them for global competition and draws from the national digital technology policy as well as Sustainable Development Goal 4 principles.

The Education Sector Strategic Plan (2016□2026) aims to enhance teaching and learning pro-cesses and outcomes through promoting teacher competencies to offer quality education. It has been an expectation that the envisaged change could bring better learner performance in physi-cal science. However, the yearly physical science (0181) examiners reports have shown poor performance, especially in the chemistry part of the syllabus (ECoL, 2020; 2021). The Lesotho General Certificate of Secondary Education (LGCSE) physical science syllabus specifies that learners need to be able to demonstrate knowledge with an understanding of scientific and technological applications with their social, economic and environmental implications (NCDC & ECoL, 2019). The National Strategic Development Plan II (NSDP II) indicates that, in the past, Lesotho's education did not translate into employable skills; hence in the 21st century there is a need for the development of skills and policies to align with the labor market. The 2005 ICT policy, on the other hand, stipulates that "educational institutions must use ICT to expand access to education as well as improving the quality of education" (Lesotho Govern-ment, 2005). However, the absence of guidelines on how ICT has to be integrated throughout the syllabus adds to the inadequate preparation of teachers for ICT implementation.

Information and communication technology (ICT) provides limitless learning opportunities that could improve learning abilities across the world among different discipline (Livingstone, 2012; Bagde, Bobde, & Bagde, 2021). However, ICT relies on the teacher's readiness and un-derstanding of ICT integration. It requires that teachers, the role players in education, use ICT efficiently and effectively to enhance education (Tondeur et al., 2016). If the syllabus intends to produce learners who are technologically competent for the future workforce in the 21st centu-ry, teacher ICT competency and attitude should be considered. Inadequate training and experi-ence of teachers on ICT integration led to a lack of confidence in ICT integration and subse-quently results in teachers' regression into their comfort zones and traditional teaching (Malik & Shafeeq, 2016). The problem arises where technology-

enabled learning obliges shifting the focus toward pedagogy with emphasis on how rather than what. The implication requires con-sideration of teachers' pedagogical beliefs (Albion et al., 2015). These fault lines have created gaps in the adoption of ICT-integrated lessons. As such, status of technology use in our schools and it is a necessary measure to equip teachers with the necessary technology skills to enhance their technological pedagogical practices. Given the advancement of professional development in schools, the main objective of this paper will be achieved in answering the following re-search question: How do physical science teachers perceive the effectiveness of professional development on ICT integration?

2. Research Methodology

2.1. General Background

2.1.1. Professional Development in Lesotho Secondary Schools

Professional development has been accepted as an essential tool toward the envisaged ICT-integration goal (Hafifah, 2020; Ottenbreit-Leftwich et al., 2018). Hero (2020) reported, using ICT in science classrooms advances teachers' pedagogical practices to develop 21st century competencies. Professional development has a positive impact on teachers' beliefs and behavior toward an educational goal. However, reviews on professional development have shown its ineffectiveness (Kafyulilo & Keengwe, 2014) because it is believed to be dynamic. Lesotho, like many African countries, such as Ghana, Nigeria and South Africa, has considered professional development for ICT integration of teachers and invested a large amount of money into incorporating ICT in education (Federal Republic of Nigeria, 2019; Muianga et al., 2019; UN, 2022). The context of the present study attempts to bring to light the consequences of ineffective professional development toward ICT integration. Kohnke (2021) indicated that the limitations that science teachers encounter in teacher training institutes are compensated by teacher continuous professional development. In Lesotho, the challenge has been to engage all teachers in professional development toward ICT-integration practices that could potentially change the teachers' pedagogical practices and improve learners' learning experiences. Therefore, the sections that follow review the literature on teachers' ICT use regarding professional technology competence.

The Survey of ICT and Education in Africa and the New Partnership for Africa's Development – Infrastructure Project Preparation Facility (NEPAD-IPPF) project used the train-the-trainer model to improve overall teacher quality in Lesotho secondary schools with technological advancement. However, the clone nature of the model did not show its effectiveness because of a lack of resources for training in schools. The project supported by Oracle and Microsoft operated in only six secondary schools which shows a very low percentile in the country (Isaacs, 2007). The Thakakhoale Project trained teachers (trainers) from teachers' associations, intending to improve the professional competency of teachers. This initiative focused on one representative from each of the subscribing schools. The program was also found ineffective in training teachers on ICT integration because teacher trainers had to train other teachers without enough technological devices and under restricted time.

The statements indicate that the initiatives were not adequately supported because of a lack of resources as well as the long time that lapsed before follow-up sessions. Li et al (2019) argue that to understand ICT integration and its importance in education, professional development must provide practices connected to the classroom situation and trainers should be knowledgeable teachers. Teacher practices through activities should employ different frameworks that explain how education should be approached (Li et al., 2019). Utilizing the same technology tools, the teachers use in the classroom for training can facilitate effective professional development and enhance their teaching practice (Li et al., 2019; Ottenbreit-Leftwich et al., 2018). Investing in the improvement of teachers' technological competencies through professional development is the most prominent gesture toward achieving the main objective of the 2005 ICT policy.

2.1.2. Exploring Ineffective Professional Development on ICT Integration

Teachers are the key factors in the determination of educational development because they address multiple forms of knowledge required for teaching and learning (Malik & Shafeeq, 2016). ICT

integration in education offers the potential to transform teacher pedagogical practices and support improved achievements through audio-visual technologies (Albion et al., 2015). The presence of ICT devices in schools does not guarantee their effective and efficient use. Technology is a support and not a teacher replacement. This implies that good technology can fail to provide expected results because of pedagogical inefficiency. Rafeeq and Ali (2021) showed that teacher effectiveness is a problematic and challenging concept and that improvement efforts are in most cases inadequate. Subsequently, the traditional way of teaching takes precedence. This prevents 21st century learners from exploring their ability to create their knowledge and delimiting their thinking toward a global perspective. Despite the government's efforts to implement ICT integration in education, there has been a slight movement toward the initiative. This shows that integrating ICT into science teaching is far from being a systemic change towards the envisaged goal.

To transform science teaching with ICT, Malik et al. (2018) suggested consideration of teachers' skills and attitudes among other factors. The pedagogical beliefs of teachers play a significant role in the use of ICT in teaching (Avisteva, 2019). It is easier for teachers to find relevant material, vary methods of teaching, and create an atmosphere conducive to learning when they are equipped with technological knowledge, pedagogical knowledge, as well as content knowledge (TPACK) together. Therefore, professional development activities are paramount for classroom practice enhancement and for improving the teaching and learning of science (Malik et al., 2018).

2.2. Theoretical Framework

This research used TPACK and CBAM as theoretical bases, as these frameworks assist and support teachers in identifying what they need to know to use ICT efficiently and effectively in their science classrooms. Integration of digital technology into education is a continuous practice (Yang & Hong, 2022). Special efforts to adequately equip teachers with effective teaching strategies drawing on the tenets of technology are a prerequisite. A teacher becomes an effective teacher if they have content knowledge (CK) including communicating it in logical and accessible ways (Yalley, 2022). Teaching strategies should enhance learning by enabling effective communication of the subject matter. According to Koehler and Mishra (2008), content, pedagogy, and technology, and the relationship between and among them, form the TPACK framework which is an extension of Shulman's (1987) pedagogical content knowledge (PCK). The framework simply describes how teachers' understanding of technologies interacts with the knowledge to produce ICT-integrated instruction. This is because teachers need to appreciate the subject matter and have a comprehension of the pedagogical strategies to disseminate the content for enhanced education and be prepared to integrate ICT into teaching.

The CBAM used was developed from Fuller's (1969) concern theory of teacher development for identifying the concerns teachers have on their professional development on ICT integration. CBAM comprises the stages of concern (SoC), level of use and innovation configuration (Hall et al., 1979). According to Sarfo et al. (2017), CBAM is guided by the assumption that: 1) change is a process, 2) change is an individual, 3) the perception and feelings of individuals are crucial, 4) the level of skill in the use of an innovation shifts as one proceeds through stages of feelings about a perception and 5) change facilitators must proceed systemically. In this study, CBAM was used to identify teachers' beliefs, teachers' personal teaching theories, and the approach of the professional development on ICT integration they acquired.

Figure 1 indicates that addressing the issue of concerns in teacher preparedness during the implementation of technology in education could guarantee enhanced professional development as the questions, uncertainties, and resistance may be eradicated. TPACK, on the other hand, involves provision of digital technology skills to teachers to enhance their preparedness to integrate ICT in education. The inclusion of teacher experiences in specific subject matter and technology use could lead to a technology infused instruction that addresses ICT integration throughout the curriculum. It explains that for enhanced and effective ICT integration, teacher professional development seeks to have certain features to be effective. Teachers' beliefs and attitudes need to be considered. Teacher's active involvement in the process is an important measure in increasing teachers' technology skills and their preparedness to

integrate ICT. Ultimately, efficient professional development would influence effective and successful implementation of ICT integration in education.
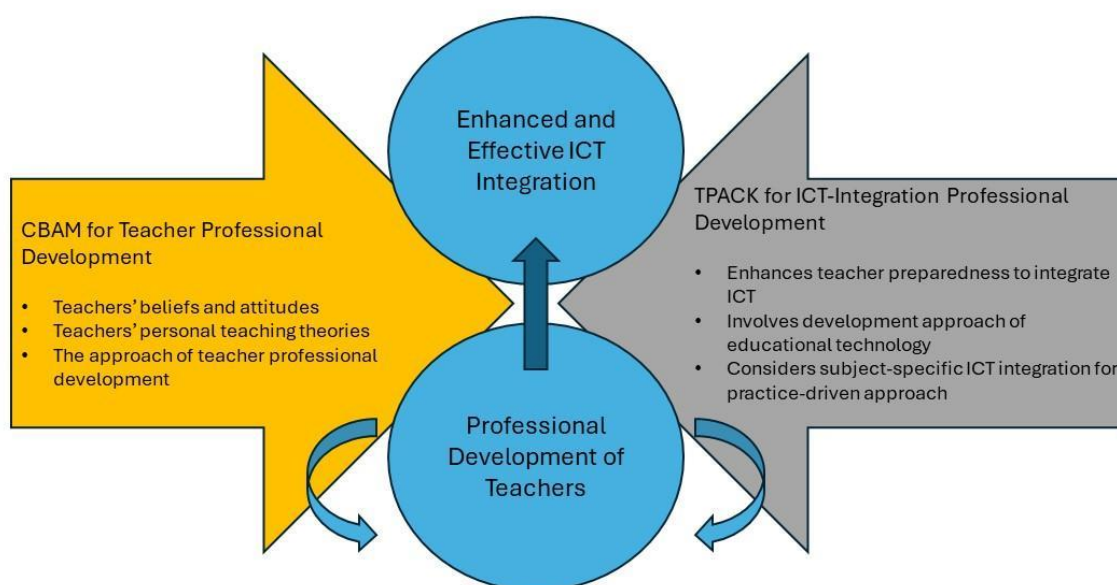
Figure 1.
TPACK and CBAM models in teacher professional development for ICT integration.

3. Methodology

3.1. Research Design

This qualitative case study was conducted in four secondary schools in Maseru to understand the perspectives of physical science teachers on professional development on ICT integration. The choice of this design was influenced by its benefit of enabling the generation of rich data through in-depth interviews (Gustafsson, 2017). Creswell (2014) pointed out that this design allows for the collection of different forms of data in a natural setting. In addition, the descriptive data collected may lead to the development of insights into how participants interpret and understand a particular phenomenon. The interpretive paradigm adopted in this study allowed us to understand the participating teachers' perspectives of professional development in ICT integration.

The study adopted purposive sampling to select four secondary school science teachers based on the teacher:

- being a physical science teacher with at least five years of teaching experience;
- having at least one professional development training on ICT integration in five years;
- teaching at a school that had been awarded a computer lab with all necessary equipment.

Demographic data on the participants are provided in Table 1. The participants' actual names have been replaced with pseudonyms for confidentiality purposes.

Table 1.
Profile of the participants.

Participant	Leseli	Khanya	Khotso	Thabo
Gender	Male	Male	Male	Male
Age	38	42	28	46
Qualifications	BSc + PGCE	Dip. Ed + BSc Ed	BSc Ed	Dip. Ed + BSc Ed
Teaching experience	15 years	14 years	5 years	17 years
Subjects taught	Biology and chemistry	Math and chemistry	Math and physics	Math and physics
ICT professional development in the previous five years (formal or informal)	Formal and informal	Formal and informal	Formal and informal	Formal and informal
Technology use (never, rarely, or often)	Often	Often	Often	Often

The data presented in Table 1 indicate that the participants were all male. In addition, all participants were involved in both formal and informal professional development on ICT integration and, to some extent, used technology in their teaching.

3.2. Data Collection

In this paper, data collected through semi-structured interviews with specific attention to narratives on ICT-integration practices elicited by professional development on ICT integration were considered. Purposive sampling was used to select the participants and their schools. The participants' schools were selected based on the availability of ICT facilities for ICT integration. The interview guide was prepared to elicit the experiences, views and concerns of the participating physical science teachers on ICT-integration professional development. To ensure the rigor of the study, measures of reliability, validity and objectivity were followed to maintain the quality of data collected by reducing subjectivity and bias (Nyathi, 2018). This was achieved by maintaining a set of sampling criteria, sending the interview guide to third parties for scrutiny, keeping records of the raw data collected under lock and key and including the participants in the data analysis to avoid misquoting.

Ethical issues were adhered to as ethical clearance was sought from the researchers' university. The MoET in Lesotho through the CEO of post-primary schools also provided permission to conduct the study in the selected schools. The district education manager also provided permission to conduct the study. The participants' autonomy and confidentiality were carefully considered and upheld as pseudonyms were used in the study (Bertram & Christiansen, 2014). To ensure voluntary participation, participants signed a consent form. The participants were made aware of the aims and objectives of the study before the data collection commenced.

3.3. Data Analysis

The narratives generated were considered for this paper. The data gathered were arranged into themes that emerged from the interviews. This was done with much attention to identify patterns that emerged during transcribing and coding of the data (Sutton & Austin, 2015). CBAM was used in this study to identify teachers' beliefs, teachers' personal teaching theories, and the approach of the

professional development on ICT integration they acquired. These themes were analyzed independently and later compared to understand the cross-cutting issues.

3.4. Research Findings

This paper presents data concerning how the four participants, Leseli, Khanya, Khotso and Thabo perceived their professional development toward ICT integration in the teaching of science. The participants believed that a technology-oriented learner has to be taught through the use of technology to promote collaborative learning. Their professional development on the use of technology in class has rendered them ineffective in the use of technology in teaching science, especially in those activities that could promote learner-centeredness. Their narratives indicate that they used technology to brighten their traditional way of teaching because they are not conversant with other computer applications that suit ICT integration for a particular content. The paper focuses on how these participants perceived their professional development on ICT integration for science education.

3.5. Professional Development on ICT Integration

Participants believed that quality education is derived from quality efficient professional development. Su and Wang (2022) and Henderson (2020) pointed out that enhancing teacher quality advances the skills and knowledge required for quality education. This shows that teachers need to have leading roles in ICT integration for instructional activities in 21st century education. In the interviews, the participants were asked if they received any form of formal assistance from the MoET regarding ICT integration. The findings show that some teachers received formal ICT training while others were trained by the trained teachers. Leseli narrated his professional development on ICT-integration as follows*: "I never got any formal ICT integration training, I acquired computer skills from the university and informal training from the colleagues who went for the training on ICT." It is clear from Leseli's response that some teachers acquired computer skills from the university and not pedagogy on ICT integration.* Khotso clarified that further training on ICT occurred through sharing the skills with colleagues or through research over the Internet: *"the only training I have acquired is from the university and from colleagues through the sharing of skills. I have also equipped myself with other computer skills through reading and research over the Internet."*

The participants indicated that their inadequate professional development influences how they teach. Nonetheless, the training from the colleagues triggered the urge for ICT integration among the participants. Leseli indicated that:

> *The training I got at the university and additional training from colleagues played a major role in my knowledge and application of ICT in my lessons. … On seeing that I could not use some new software applications, I used Google and watched YouTube videos on how some things are done. I found the use of ICT easy after hands-on training offered by colleagues.*

Leseli and Khotso indicated that they had been exposed to informal professional development on ICT integration which affects effective ICT integration in teaching. Their responses affirm what Dumlao (2020) highlighted, that the knowledge teachers gain at training centers has little relevance to what they need in the classroom. This scenario shows that teachers are equipped with computer literacy skills and not on pedagogic perspectives of ICT integration.

Some participants portrayed a positive impact of the training they received on ICT integration. Khanya shared his experience with regard to professional development on ICT integration:

> *I am a treasurer in the national committee of Lesotho Science and Math Teachers Association (LSMTA). This has granted me many opportunities to attend several training workshops organized by the MoET. I also attended training workshops organized by the Ministry of Communications, Science and Technology under a project called Thakakhoale.*

Khanya can prepare slides, graphs and simulations for teaching from training workshops he attended. He is also entrusted with training other teachers from schools that subscribed under the LSMTA. Khanya had acquired skills that enabled him to use ICT in his lessons. Thabo indicated that he is well conversant with computer applications, as he elaborated on the training he received on ICT as

follows: "I think I got all forms of professional development towards ICT use in my lessons. I did computer studies at college and was already computer literate when I got to work." This did not prevent him from seeking continuous professional development from other platforms. He clarified on his further training on ICT as follows:

> *I went for ICT training in 2008. This training was provided by School Net SA. It was on Microsoft Office, e-mailing, a little bit of programming and how to use Microsoft Excel. The training I got equipped me with skills to teach ICT education confidently. It has made my work easy as I easily get information through the internet and arrange it to suit my lesson needs.*

According to Thabo, the computer studies skills he acquired from college were not enough to respond to the challenges of using technology to teach effectively. Hence, continuous professional development on ICT integration was a necessity. The excerpts above indicate that the participants received different forms of professional development. Leseli and Khotso received informal professional development, while Khanya and Thabo received both formal and informal professional development on ICT integration. It can be deduced from their responses that they approached ICT integration differently. Leseli and Khotso only use those applications which they are confident and competent to use. Arkorful et al. (2021) and Li et al. (2019) showed that the success of ICT integration depends on the quality of teachers' professional development. According to this finding, it could be stated that teachers have a positive attitude toward ICT integration. However, they face a challenge in effectively and appropriately using technology in teaching and learning due to inadequate knowledge on ICT integration.

3.6. ICT integration in Teaching Practice

On participants' views on application of ICT integration, participants were asked how the training on ICT affected their teaching. Khanya and Thabo indicated that they are motivated and are confident and competent to teach using technology. These participants linked the significance of ICT integration to improved participation in class and submission of assignments because there is vast information to tap from when technology is used. Thabo indicated:

> *I am highly motivated and optimistic about ICT. It provides easy access to valuable information at the disposal of both the teacher and the learner. When taught with the help of ICT learners showed more interest and the rate of submission of assignments increased.*

Khanya gave his opinion: "Learners use technology for communication and for other things. Technology-related applications are at their finger-tips; hence teaching learners through technology could be enticing to them." On the other hand, Leseli and Khotso opined that professional development on ICT integration is a crucial activity toward the effective implementation of ICT integration in curriculum practice. The participants indicated that they still needed some training on ICT integration because there are some computer applications they cannot use confidently. This creates traditional lessons decorated with technology which render the learners as passive participants. Leseli indicated that: "I use some technology applications for teaching, however the syllabus does not state how it has to be done, therefore I do it my way." Khotso argued that: "The skills that I acquired are not enough to allow for effective ICT integration, but I am still learning some applications." This statement indicates that ICT-integration incompetence is a hindrance to the effective use of ICT tools in teaching. Khotso specified that he is not fully prepared to integrate ICT into his teaching.

He felt that the training he received from colleagues and from research over the Internet was not enough for him to integrate technology confidently and competently in his teaching. Therefore, he uses technology where he can and how it suits him. He showed that he is not confident when he said: "some of these learners are computer literate and are computer technicians. I do not want to blunder in front of them." On the same account, Leseli said: "I do integrate ICT in my teaching, but not always." ICT integration as it seems, is not easy if preparation is not adequate. Kaya and Godek (2016) stated that "professional development in teaching is an ongoing process which starts with pre-service education and continues through in-service education and change is essential in this process" (p.2636).

3.7. Beliefs and Attitudes

A good educational move is to integrate ICT into education systems, since new digital technologies keep emerging (Arkorful et al., 2021). It is important to consider factors that may affect the infusion of ICT into teaching. Teachers are lead players in the implementation of the innovation. Their attitude toward ICT integration determines the extent to which ICT integration will be implemented (Avisteva, 2019). This is shown in the participants' responses, as they acknowledged benefits from the use of ICT. These participants believed that ICT integration is a more effective process suitable for different learning styles. On this note, Leseli explained that: "the traditional methods which were used in our time no longer operate in this era." Khanya opined that: "this is the easiest way of learning from anywhere." In addition, Khotso argued that: "using ICT or technology enhances the learners understanding of concepts." The responses indicate a positive attitude by the participants toward ICT integration. This may positively affect the professional development provided and prepare teachers for an anticipated change.

4. Discussion

The findings from the interviews indicate that participants seemed to be aware of the need for ICT integration. Participants were adamant that advancing the use of technology in science teaching requires the teacher to be creative and knowledgeable. Luhamya et al. (2017) considered ICT integration as a powerful learning environment for learners to experience self-directed learning through simulations and videos. However, the evidence presented of the use of ICT in teaching science may conveniently emphasize sophisticated traditional teaching. In some cases, ICT is not used to effectively implement learner-centered lessons. The participants indicated that the gap in technology use between learners and themselves impacts their confidence and competence in ICT integration. Research has indicated that to positively affect the learners' engagement with technology, professional development on ICT-integration pedagogies is a prerequisite (Rafeeq & Ali, 2021).

Providing technological pedagogical knowledge training for teachers may enhance their competence to use ICT to create an ICT-based learning environment that engages learners in their learning of science. According to Alghamdi (2020) and Rafeeq and Ali (2021), there are many opportunities that teachers can use to introduce technology in their teaching which could enhance their creativity in the teaching of science. A lack of confidence and competence influences willingness to integrate ICT in teaching instruction (Avisteva, 2019). The data presented indicate that the attitude created toward ICT integration affects the frequent incorporation of ICT in teaching. This indicates that more effort is needed on the relevance of the training toward what is needed in the classroom. Dumlao (2020) and UNESCO (2016) considered ICT integration in teaching to need further teacher training from a pedagogic perspective. Ghavifekr and Rosdy (2015) echoed that there is a need to train teachers on pedagogical practices in ICT integration rather than on the use of technological devices. Kohnke (2021) and Dlamini and Mbatha's (2018) study showed that teachers' professional development requires transformation to enhance professional growth to promote quality education.

The concealed professional development advances in this case may be regarded as an obstacle to effective ICT integration. This shows that there is a direct relationship between the technology competence of a teacher and the quality of education in 21st century education. In this case, to achieve the requisite standard of education, it is advisable to ensure the technological competence of science teachers.

5. Conclusion

This paper reviewed the in-depth narratives of four physical science teachers on professional development and digital technology integration. The narratives indicate that the professional development and digital technology integration offered to teachers has to go beyond computer skills. Consequently, the findings suggest that the inefficient professional development on digital technology integration leads to physical science teachers hesitating to use technology. On the other hand, the paper indicates that physical science teachers are confronted with challenges, such as lack of infrastructure such as electricity to support technology integration for teaching content in schools. This challenge has

been shown to lead to the regression of teachers into traditional ways of teaching where learners are passive. As a result, the study concludes that the inadequate professional development on digital technology has a significant impact on the use of technology in the teaching and learning process.

The study proposes that teachers in Lesotho should be trained on pedagogical practices on digital technology integration to enable them to create a learner-centered environment in which learners can take control of their learning. It is evident from the participant narratives that teachers' attitudes and competencies for digital technology integration are a crucial factor. Therefore, efforts must be made by all the stakeholders in this technology-based society to improve the teachers' skills in technology to apply appropriate technologies in the teaching and learning process of physical science. This may be achieved by providing adequate ongoing professional development for improving pedagogical practices on the use of modern technology.

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