EXPLORING TEACHERS' VIEWS ON THE USE OF TECHNOLOGY IN THE TEACHING AND LEARNING OF MATHEMATICS IN BOTSWANA PUBLIC AND PRIVATE SCHOOLS

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Abstract
Improving performance in mathematics has remained a major challenge for education stakeholders in Botswana and beyond. With the role of teaching and learning strategies in improving performance in mathematics well established, this study explored teachers' perspectives on the use of Education Technology (ET) in teaching and learning of mathematics in Gaborone. The study uses a phenomenological qualitative research design underpinned by interpretivism. Data was collected by means of oral interviews and was collected from 16 mathematics teachers selected from eight public and private schools. The findings showed that private schools applied technology more robustly than their public counterparts. However, power cuts, internet cuts, and lack of dedicated classrooms for teaching of mathematics were major hindrances to applying technology in the schools. Public schools were further hindered by lack of resources, training, monitoring, and supervision, with some of the available resources not being put to good use, especially by learners. Public school participants however concurred with private school participants that technology had the capacity to improve learning outcomes when applied correctly. These findings underscore the need for improved technology at the level of policy and practice, especially in public schools through public-private partnerships.

Keywords: Mathematics, phenomenology, interpretivism, Education Technology, Botswana, public and private schools.

1.0 Introduction

Mathematics is important in the understanding of almost every other subject in the curriculum of most countries, and failure to comprehend the tenets of the subject will have

enormous adverse effect on almost all the sectors of the economy in any nation (Alzahrani et al., 2017). Great strides have therefore been made in the development of research-based evidence and theories for effective learning, teaching, and understanding of mathematics (Kazemi, 2001). However, despite the numerous efforts towards improving the understanding of the subject, it has remained undesirable to learners in different parts of the world. This undesirable nature could be attributed partly to learners' factors, such as attitude, language barriers, and ill-discipline, and to teachers' factors, such as lack of appropriate professional training and pedagogical content knowledge (Mabena et al., 2021).

In Botswana, mathematics has remained a core subject in the country's curriculum despite reports that it will be an optional subject at senior secondary level (Sennamose, 2024). To make mathematics more desirable to learners, several methods of teaching such as brainstorming, question and answer, discussion and lecture methods have been applied by teachers in the country to improve the understanding of the subject. These are indeed steps in the right direction since out of all the factors that influence the understanding of a particular subject, the teaching and learning strategies applied by both the teachers and learners have enormous potential to influence performance in that subject directly (Alzahrani et al., 2017; Gagic et al., 2019; Toropova et al., 2019). However, the ineffectiveness of the efforts towards improving performance in mathematics in Botswana is imminent in the continuous decline of learners' performance in the subject as seen in the Botswana Examinations Council's reports in 2018 and 2019 with 28.60% and 25.50% pass rates respectively (Botswana Examination Council, 2019). This underlines the need to design contemporary teaching strategies which could lead to better achievement in mathematics result and the understanding of the subject concepts (Rockstroh, 2013).

Several bodies of literature have given credence that the use of ET in mathematics classrooms has a positive effect on learners' achievement (Li & Ma, 2010; Cheung & Slavin 2013; Pilli & Aksu, 2013). In addition to improving learning capabilities and motivation of students, ET helps learners to be more engaged in the learning process and in turn helps teachers to provide flexibility and individualized learning opportunities for their students (Eyyam & Yaratan, 2014). Despite these numerous advantages, the extent teachers apply ET in the teaching and learning of mathematics, the challenges they face, and the impact of these educational tools on learners learning in Botswana is unknown. This study therefore explored the views of teachers in public and private schools on the use of ET in the teaching and learning of mathematics. This was done using mathematics teachers in selected public and private secondary schools in Gaborone. The study was inspired by the researchers' interest for improved performance in mathematics in Botswana, especially in the face of declining quality of education (Makwinja, 2022; Suping, 2022) and the disruptions caused by the COVID-19 pandemic.

2.0 Background to the study

The Government of Botswana has made several reforms towards improving the quality of education in the country. Some of these reforms such as National Commission on Education

(Education for Kagisano) of 1977, the Revised National Policy on Education (RNPE) of 1994, the Junior Secondary Education Improvement Project (JSEIP), Education Training Sector Strategic Plan (ETSSP), and the Primary Education Improvement Project (PEIP) were aimed at building a society that is learning-oriented, and reinforcing educational, cultural and international cooperation (Republic of Botswana, 2015). In line with the argument raised by Kimani et al. (2013) policies put in place in developing countries are usually implemented poorly or not implemented at all. The failure of these policies in Botswana is reflected in failure at primary and secondary levels of education (Makwinja, 2017) which is suffered mostly in mathematics at the junior secondary (Maimela, 2016; Salani, 2019) and senior secondary levels of education (Botswana Examination Council, 2019). Although the poor performance of students in mathematics can be attributed to several factors, Tabulawa (2009) argues that the teaching strategies have the most notable impact in Botswana. This was why education stakeholders in Botswana introduced an in-service Education and Training (INSET) for teachers through the Strengthening of Mathematics and Science in Secondary Education (SMASSE) programme. This was informed by the fact that improving the quality of education depends on improvement of quality of classroom practices (Haseena & Mohammed, 2015). Despite these efforts, studies by Salani (2019) and Kereeditse (2021) have shown that the objectives of SMASSE are far from being achieved in Botswana education sector.

For Botswana to be on the same pedestal with global economies, the country must produce graduates with 21stcentury skills such as information and communication technology literacy, creativity, critical thinking, and problem solving (Joynes et al., 2019). This is only possible if education standards are aligned with these skills (Boikhutso & Molosiwa, 2019). Despite the numerous policies put in place to foster the transmission of these skills, implementation has remained a major challenge. The methods of teaching applied by teachers seem not to be yielding the desired result, hence the need to explore other strategies such as the use of ET in the teaching and learning of mathematics.

3.0 Theoretical framework

This study was guided theoretically by the Instrumentation Theory propounded by Rabardel (1995). The theory "calls for an anthropocentric approach to technical objects and systems as a complement to purely techno-centric approaches" (Laisney & Chatoney, 2018, p. 4). The theory is of the view that technical systems and/or objects should not be considered from the technical aspects only, but also from non-technical aspects. This entails examining the technical objects from the point of view of the users of those objects and designing these objects with the users in view (Rabardel, 1995). So, artefacts, tasks, and humans "form a whole driven by the intentional acts of the subject and directed towards a desired result" (Laisney & Chatoney, 2018, p. 4).

There are three major poles when using an instrument. The first pole is the subject who is the user or operator of the instrument; the second pole is the instrument which is the tool or machine used by the first pole, while the third pole is the object towards which the instrument is used. Three major types of interaction when using an instrument are the interactions between

the instrument and the subject, subject and object, and interactions between the instrument and that upon which it enables action to be taken (Verillon & Rabardel, 1995). These interactions must be carefully measured so as to achieve the aims and objectives of using an instrument in the first place.

The instrumentation theory was relevant to this study because instruments are viewed as tools for changing the user's behaviour and this must be done carefully to yield desired result. In this study, it is assumed that ET (the instrument) can be used to improve the performance of teachers and learners (the subjects) in the teaching and learning of mathematics. Failure to use ET properly by both the learners and the teachers could lead to undesirable result. It is therefore the role of the educators to channel the learners properly so that they can benefit maximally from ET which has proven to be effective in engendering better performance in mathematics (Pilli & Aksu, 2013). It was therefore not clear before this study if mathematics teachers in Botswana were equipped with the necessary skills and instruments that were used to impart knowledge and improve the performance of both the teachers and the learners.

4.0 Research questions

The study sought to answer the following questions.

a) How do teachers apply ET in the teaching and learning of mathematics in public and private schools?
b) How are the challenges faced by teachers in the use of ET in public and private schools comparable?
c) What is the impact of ET on the learning of mathematics in public and private schools?

5.0 Literature review

ETs are the different technologies used in teaching and learning (Seels & Richy, 1994; Dron, 2022). The different forms of ET tools that are used in pedagogy include high-tech computer hardware, instructional media including videotapes and transparencies, and other technologies, including activities, techniques and methods for planning, implementation and evaluation of effective learning experiences (Newby et al., 2006; Shara, 2020). These tools are applied for program goals (Bonifaz & Zucker, 2004), in teaching and learning (Cheung & Slavin, 2013; Adom & Aravind, 2019), for sharing content materials and reminders (Mafa & Govender, 2018), and for providing cultural, organizational, procedural, individual and instructional opportunities for teachers and students alike (Hawkers & Cambre, 2001). These literatures however failed to show the tools that are available for mathematics teachers in private and public schools in Botswana and the extent they use these tools in teaching and learning of the subject. This is why the first research question explored how teachers applied ET tools in teaching and learning of mathematics in public and private schools.

The different barriers to the use of technology in classrooms include poor knowledge/lack of training, lack of support, lack of access to technology, lack of competence, ineffective trainings, lack of monitoring and supervision, corruption, linguistic and socio-

cultural factors, historical factors among others (Nkhwalume, 2013; Dintoe, 2016; Martirosyan et al., 2017; Shafei, 2020; Shoba, 2020). Most of the available literature either failed to show the challenges faced by mathematics teachers specifically or how the challenges faced in private schools can be compared to public schools especially in Botswana context. This is why the second research question explored the perspectives of teachers in public and private schools on the barriers to the use of technology in mathematics classroom.

Several studies also give credence that different technologies can improve students' learning and academic performance (Eyyam & Yaratan, 2014; Sawaya & Putnam, 2015; Salani, 2016; Mafa & Govander, 2018; Akcay et al., 2021). These studies again failed to show teachers' perspectives on how the students' learning in public schools can be compared with their private counterparts. This informed the choice of the third research question which explored teachers' perspectives on the impact of ET on students' performance in private and public schools. Literature argues that private schools perform better than public schools (Shabbir et al., 2014; Scheper, 2013) even in Botswana context where studies making such comparison are limited (Letsholo & Alimi, 2019). This is why each of the research question posed in this study compared and contrasted the findings from private schools with those from public schools. The findings have contributed to the limited literature that compares private and public schools in Botswana.

6.0 Methodology

This study adopted an interpretivist research paradigm which seeks to understand the interpretation of the interaction between individuals and a social phenomenon (Rehman & Alharthi, 2016). In line with interpretivist paradigm and in a bid to ascertain the perspectives of teachers on the use of ET in teaching and learning of mathematics, this study adopted a qualitative research approach. This approach was effective for this study as it enabled the researcher to get more details by involvement in the actual experiences of the participants (Mohagan, 2018). This study adopted the phenomenological research design which uses "analysis of significant statements, generation of meaning units, and development of essence description to study the participants" (Creswell, 2009 p. 171).

The population for this study was mathematics teachers in public and private Senior Secondary Schools (SSSs) in Gaborone. Mathematics teachers were chosen because they are charged with the sole responsibility of using different pedagogies in implementing mathematics curriculum in Botswana. Public and private schools were chosen because available studies failed to draw a comparison on the perspectives of teachers in using ET as a teaching and learning tool. SSSs were chosen as the population because this level of education prepares the recipients for higher education and for useful living within the society (Nwakpa, 2017). Gaborone was chosen because the researchers wish to improve mathematics performance in the region. Such performance can then be transmitted to other regions in Botswana since most of the policies in the Botswana education sector are first implemented in Gaborone. The sample size for this study was 16 mathematics teachers selected from four

private and four public SSS in Gaborone. According to Hennink and Kaiser (2022), nine to seventeen samples are suitable for achieving saturation in a qualitative study.

Semi-structured interviews were employed to fully understand the practicality of ET in the teaching and learning of mathematics in private and public schools in Gaborone. Interviews were conducted both face-to-face and on the telephone. The interviews were recorded using audio tapes and handwritten notes by the researcher after due permission from the participants. Data were analyzed thematically, and appropriate steps were taken to ensure data trustworthiness. Ethical considerations that were made in this study were obtaining ethical clearance from the office of research and development at the University of Botswana, seeking consent from the participants, and ensuring anonymity and confidentiality.

7.0 Findings and discussion

7.1 Application of education technology in teaching and learning

In line with the first research question, this section presents participants' views in both private and public schools on the extent they applied technology in mathematics classrooms. The participants in public schools highlighted the technologies they applied in their mathematics classrooms including WhatsApp messenger, chalk board, and calculators. Other technologies such as laptops (personal computers) and internet were recently introduced in some public schools while some others had little to no access to such technologies. These views are captured in the quote below:

> *At the moment we rely much on WhatsApp….But some technologies like... Window… OneNote…There has been an introduction of OneNote…. PowerPoint…but they have…we have not fully started to use them. We also have internet…I rarely use it in lesson presentation mainly because our internet is not reliable. So, I use internet, mostly my personal internet, during [lesson] preparation.*

The majority of public-school participants do not use technology in the classroom, but they apply them mostly in lesson preparation, searching concepts they do not understand and in confirming solutions to mathematical problems; for research; and for revision. They were not aware of some technologies such as gamification, peer instruction and flipped classroom despite the introduction of new syllabus called Outcome Based Education (OBE), wherein teachers were expected to make more use of technologies in their classrooms.

On the other hand, the views of participants from private schools showed that they applied more technologies in their classrooms than their public counterparts. Such technologies include virtual presentations with laptops, and smart boards connected to Wi-Fi (internet), use of Microsoft Teams, emails, Google Classroom, graphic pads, PowerPoint and interactive white boards/digital boards, use of WhatsApp, projectors and Smart Boards; and posting of videos on designated YouTube channels where students are allowed to request for videos on any topic of choice. This is captured in the quote:

> *I normally use my laptop for presentations in my lessons…but not for every lessons…of course a projector is also used for my presentation...PowerPoint to be precise...yes that's it. Oh...I also use Teams, especially during vacation and during weekends, yes... Oh yes...I sometimes make presentations...during these presentations. I show my students videos on YouTube...something they really enjoy. During the era of Covid...when it was difficult to have a physical interaction with students, I used Teams to conduct lessons...send assignment...and I also use email and WhatsApp, yes. Basically, that's it.*

The private school participants further opined that they used technology in lesson planning, especially in topics with many diagrams and graphs, dissemination of information, and during introduction and summary of lessons so as to concretize teaching and learning. Just like public school participants, the participants in private schools seldom applied technological strategies such as peer instruction, gamification, and flipped classroom.

One theme that emerged from the first research question is that participants in private schools applied more technology than their public counterparts, especially in the wake of Covid-19 pandemic. The participants in public schools applied common technologies such as WhatsApp messenger, chalk board, and calculators in mathematics instructions. This confirms previous study by Salani (2013) that the calculator is the major technology in mathematics pedagogy in Botswana. The private school participants however used more advanced and complex technologies such as Microsoft Teams, projectors, interactive white boards, laptops for virtual presentations, Smart Boards, and graphic pads among others. They also posted videos on YouTube channels to allow students learn at their own pace. The advanced technologies seen in private schools is capable of improving learning capabilities, motivating students, and engaging them in the teaching and learning process (Eyyam & Yaratan, 2014). They aid students to access ideas and information capable of enhancing knowledge ownership (Shara, 2020), and provide excellent avenues for instruction and exploration (Barron et al., 2006).

Although most of the educational tools were introduced in the private schools due to the Covid-19 pandemic, the studied schools have continued to use them in the post Covid-19 era. This is in line with Instrumental Genesis (IG) which is central to instrumentation theory that underpinned this study. IG is of the view that a tool changes from a mere artefact to an instrument which can be used to transform both the tool and the user (Olive, 2011). The private school participants had a broader application of technologies in lesson planning, presentation of lessons on topics with diagrams and graphs, dissemination of information and in making the idea behind a particular topic concrete using real life applications. This shows that private school participants have gone beyond the views of Mafa and Govender (2018) that technology is mainly used in Botswana for sharing educational content materials, comments, and reminders about tests, assignments, and other class materials.

Another theme that emerged from the first research question is that gamification, peer Instruction and Flipped classroom are not popular in both private and public schools. None of the participants knew about gamification which enables learning through computer-based games (Adom & Aravind, 2019). One participant in public school made use of peer instruction manually, but not on a regular basis. This involved the candidate going from student to student in order to confirm their answers to a given task. This is time consuming, thereby making the participant not to use it on a regular basis. Peer instruction is better done using mobile devices, where challenging questions are posed to students and their answers collected in a matter of minutes as a pool. This aids in learners' participation and in clarifying misconceptions that may have arisen during instruction (Adom & Aravind, 2019). The participant in private school that claimed to use peer instruction in teaching and learning however failed to give a correct illustration of the teaching strategy. This shows that peer instruction, just like gamification, is not so popular among teachers and learners in Botswana. The majority of the participants also had no knowledge of flipped classroom which allows teachers to bring in activities done outside the classroom into the classroom (Mehring, 2017).

7.2 Hindrances to the use of ET in teaching and learning

7.2.1 Power cuts and unreliable internet in public and private schools

The findings from the second research question showed that the major challenge faced by mathematics teachers in applying technology in their classrooms was power and internet outages. The participants in both public and private schools used words and phrases such as "lack of internet", "no Wi-Fi", "poor signals", "unreliable internet", "power cuts", "Wi-Fi and internet issue", and "power disruption" to express their views in this regard. The participants also highlighted that the environment is not conducive for the use of technology, and there are no dedicated classrooms for hands-on teaching and learning of mathematics.

> *I would say....no dedicated classroom. We have not been allocated rooms that are meant to be used for integration of these technologies in teaching and learning. We also experience power cuts which disrupt the use of computers...Also...internet outages...Wi-Fi outages.*

The public-school participants also mentioned that lack of other resources such as projectors and smart boards, and time constraint is hindering them from applying technology in their classrooms. The participants in private schools noted that their major challenge was majorly not resources, but inability to integrate available resources in teaching and learning of mathematics. This is usually due to limited time for completing the termly scheme of work as seen in the words below:

> *The challenges...the line that I'm thinking is...I don't think it's a matter of resources...I think it's how we can integrate this technology...because sometimes mathematics students, you have to engage them first...mostly now you have to illustrate it...be it on the board...if you are using the white board. In mathematics you have to be more innovative in incorporating...like the YouTube channel I was talking about...yah...I*

think the integration part is where we are lagging behind. Mostly we have a lot of things to cover in a term. These technologies can be time consuming when we apply them in the classroom...and we always want to complete our scheme in a term.

7.2.2 Lack of training and supervision in public schools

Findings from the second research question also showed that there is lack of training, monitoring, and supervision on the use of technology in public schools. This is not surprising since the majority of participants in public schools opined that they lack numerous technological tools needed for teaching and learning of mathematics.

No, we were not trained...and I wish we could be trained...on that one. Kana [Perhaps] for students to understand, as a teacher first I must be trained...yaahh..yaahh (nods his head)…that is the best way...No...no monitoring at all. But since now...end of last year...we were being given some laptops...we are hoping for improved...monitoring and usage.

On the other hand, the majority of private school participants were trained to use the available technologies in their schools such as smart boards and Microsoft Apps among others.

Yes.....even when the smart boards came...we had some training... I once did a course with Cambridge...where they were highlighting some of the technologies used in mathematics...where you draw graphs...input functions...then you are drawing graphs. Yes...there's...there's always constant supervision and monitoring.

For technology to be used effectively in schools, it must be carefully integrated so that such technology would not be obstructive rather than effective (Shafei, 2020). Findings from the second research question raised numerous concerns about the integration of technology in Botswana public and private schools. While some concerns were common in both private and public schools, some were unique to only public schools. Both sets of participants attested that power supply, internet services, time constraints and no dedicated classrooms are major bottle-necks to applying technology in their classrooms. The power and internet outages experienced by the participants are in line with what is observed by an average citizen of Botswana, especially those in rural communities. The issue is therefore not peculiar to schools, but it also applies to other institutions in the country. This confirms the assertion by Balogun (2015) that lack of public facilities, corruption, socio-cultural factors, political and economic factors, and poor administration and leadership are hindering the use of technology in teaching and learning in African schools. This also confirms that the slow adoption of technology in schools is mainly hinged on historical and contextual factors (Dintoe, 2016). Another challenge raised by the two sets of participants is limited time for proper incorporation of technologies in their classrooms. Every term, teachers are given saturated schemes of work which they are expected to complete within a specified time. This makes teachers to focus more on covering the scheme of work using teacher-centred approaches, without considering the use of technological devices. This is confirmed by Nkhwalume (2013) who opined that inadequate time and administrative

support is hindering the use of ICT in the teaching and learning of mathematics in Botswana. This could be why the private school participants pointed out that their major challenge is not resources for teaching, but how to integrate those resources within a specified time to achieve the aims and objectives set for a particular term. Lack of dedicated classrooms for hands-on teaching of mathematics confirms the views by Udeh et al. (2017) that non-existence of mathematics laboratories for hands-on teaching is a major hindrance to the use of ET in the teaching and learning of mathematics.

The challenges that are peculiar to public schools are lack of resources, training, monitoring and supervision, and lack of dedicated classroom for the sole purpose of mathematics. These challenges are in line with several bodies of literature (Bingimlas, 2009; Raulston & Alexiou-Ray, 2018). This supports the findings by Martirosyan et al. (2017) that the major barriers to using technology in classrooms are lack of resources, and lack of support and training on how to use technological tools. This also confirms the need for mathematically related resources to enhance problem solving during mathematics lessons (Shoba, 2020). The instrumentation theory comes into play in this regard. The findings from participants in public schools show that they are lacking the second pole, the tool, used by the first pole, the subject. This results in lack of interaction between the instrument and the subject typical of instrumentation theory (Verillon & Rabardel, 1995). Although the majority of the participants in private schools opined that they are trained on the use of technology, Shafei (2020) argued that such trainings are not usually effective, as they are not allowed to demonstrate and practice what they have learnt on the spot. This could be why one of the participants in private school opined that though they were trained, monitored, and supervised on the use of education technology; the trainings are usually not enough. Above all, sufficient time, technical support, and effective professional development are important for proper integration of the three poles needed for effective implementation of technology in classrooms (Bingimlas, 2009).

7.3 Impact of education technology on learning experiences

The participants from public schools gave varying, but related views on the impact of ET on students learning. They affirmed that it was difficult for them to state the impact of ET on the learners since they did not have enough technological tools for teaching and learning. They also opined that even technology such as laptops that have been made available to the learners were being used for wrong purposes.

> *They can have impact;...they can...provided now we give them resources...like we have given them laptops...but issue now...no Wi-Fi...around. But the way they enjoy looking at them...I think it will help them to improve research and collaboration...working together...even the skill...kana we have a shortage of that skill. The students are motivated when using technologies....the only issue is that...it's like they are motivated...using it wrongly...you know...for taking videos for us teachers...as we are teaching...they try to take those videos...and you know, koore...which means when you are...you can just focus. I think they can have that positive impact. But they can enjoy...when we use them properly than when we don't...because...kana most time...tota*

they are bored by...this monopoly...the one used from back then. The technology can help them to...have that attraction...it seems it can be a good one...in that way.

The participants in private schools gave more insight on the impact of technology on learners in the mathematics classroom. This is obviously because they applied technology in their classrooms more than their public counterparts. Words such as "engagement", "captivated", "enjoy", "interest", "captured", "motivated", "intrigue" and "curious" were used by the participants to express their views on the impact of ET on learners' performance. For them, technology improves learning by captivating and capturing their attention, and making them to be engaged throughout the lesson, even if the use of technology is stopped in the middle of the lesson. This reduces the low attention that is experienced when the normal white board is used for teaching and learning.

Previous studies (Eyyam & Yaratan, 2014) have shown that learners have positive attitude towards the use of technology in the classroom, and this culminates to improved performance. It was however difficult to confirm this assertion using the public-school participants selected in this study. This was because the majority of the public-school participants opined that the impact of using technology on their learners have not been fully realized since they did not have access to numerous technological tools. The private school participants however posited that using technology in classrooms can lead to improved collaboration and research abilities of learners. This supports the findings by Salani (2016) that technology engenders learners' participation, motivation levels and problem-solving ability.

The public-school participants also argued that technologies such as laptops that have been made available to the learners are being used for wrong purposes such as watching of movies among others. This could be why previous study by Salani (2016) affirmed that in Botswana, technological tools can promote laziness thereby hindering arithmetic skills. As reflected in the instrumentation theory, humans, tasks, and artefacts are supposed to be driven intentionally towards the desired result (Laisney & Chatoney, 2018). Therefore, the use of technological tool for the wrong purposes as highlighted by public participants is against the instrumentation theory which argues for proper interaction of instrument, object, and subject in order to realize the full potential of a particular instrument (Verillon & Rabardel, 1995). Instruments can only lead to changes in structure, function, and cognition of the subject if they are used properly. The onus is therefore on educators to sensitize learners on proper use of available technologies. It is however not surprising that the public schools were unable to educate their learners on the proper use of technology. This is because the majority of the participants from public schools stated in the previous research question that they lacked training, monitoring, and supervision on the use of education technology.

The views of the participants in private schools show that using technology in the classroom intrigues the learners, captivates, and captures their attention, and keeps them engaged throughout the lesson. This shows that education technology can increase academic performance by enhancing teaching and learning (Mafa & Govander, 2018), and it allows

educators to explore different mathematical concepts by relating them to real-world problems (Sawaya & Putnam, 2015). The training and supervision that were made available to the private school participants as seen in previous research question could be why they were able to guide their learners on the proper use of available technology to achieve desired results. In addition to the instrumentation theory, this supports the argument raised by Pilli and Aksu (2013) that educators have prominent roles to play in channelling the learners to benefit maximally from education technology. An illustration of how the participants in private schools were able to play this role effectively is seen in the words of a participant who opined that learners who found it difficult to make use of their textbooks always showed interest in using such textbooks if they could access them with their phones. Having such books in their phones could help minimize the time they spend on social media and other frivolities.

Finally, another striking finding from the private school participants was that technology saved time during teaching and learning. This contrasts previous claims from the same set of participants in this study that integration of technology in the classroom is time consuming. It is therefore evident that with proper training and supervision, the use of technology in the teaching and learning of mathematics can save time, increase participation and collaboration, motivate learners, and lead to improvement in their overall performance.

8.0 Implications of findings

The findings of this study have implications for policy, practice, and further research. In terms of policy, the government of Botswana needs to do more towards improving the quality of technological tools for teaching and learning in public schools so that they could be on par with their private counterparts. As of 2020, the Botswana government spent 8.7% of her gross domestic product on education, which was an increase from the 6.9% spent in 2019 (UNESCO Institute of Statistics, 2022). Since education is the most powerful tool for national development, more resources should be channelled to the education sector. A huge chunk of such resources should be directed towards enhancing the level of technology in schools so that learners would be well equipped with 21st century skills. Provision of laptops for learners in public schools by the government is a step in the right direction. However, there is need to ensure that the gadgets are distributed equitably to learners. There is also need for improved training of teachers in public schools so that they can guide their learners on the proper use of available technologies. It is imminent from the findings of this study that the inability to guide learners on the proper use of technology results to negative impact on their performance.

Power and internet cuts are major challenges faced by private and public schools. This calls for public-private partnership (PPP) to remove this bottleneck. Such partnership could also be extended to the training and re-training of teachers on the proper use of technology. This will make the process less expensive and more sustainable. The training should be followed by monitoring and constant supervision to ensure that teachers are actually using the available technologies properly. There is also need to provide dedicated classrooms for the teaching and learning of mathematics. Just like there are laboratories for other science subjects like chemistry, physics, biology, and computer science, schools should work towards providing

a mathematics laboratory for hands-on teaching and learning of mathematics. Such laboratories should be equipped with education technological tools for effective teaching and learning of mathematics. This will help to save time since teachers will not have to take the technologies to the classrooms and set them up; rather, they will take the learners to the laboratory where the technologies are already set-up and ready for use.

Finally, there is need for further research on the application of technologies in other levels of education, and in rural communities in Botswana. These studies should be carried out from time to time so as to ensure that both private and public schools in rural and urban communities are duly updated with recent technologies.

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