Mathematics teachers' perceptions on Information and Communication Technology integration in teaching and learning

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Abstract
This study explored Grade 12 mathematics teachers' perceptions of using ICT tools in teaching and learning. Adopting a qualitative approach with an exploratory design, the study purposively selected four participants who were interviewed using semi-structured interviews. Data were analysed thematically through coding and categorization. The findings revealed several challenges hindering effective ICT integration, including insufficient training, overcrowded classrooms, limited ICT resources, and inadequate institutional and national support. While ICT tools were available, teachers struggled to utilize them fully. Some viewed ICT as time-consuming and complex, whereas others recognized its potential to enhance cross-curricular competence and learner engagement. Despite these challenges, teachers acknowledged the motivational impact of ICT integration. The study concluded that merely deploying ICT tools does not guarantee their effective use. To enhance ICT adoption, policymakers should align national education standards with teachers' expectations and provide targeted support to ensure meaningful integration into mathematics education.

Keywords: *Information and Communication Technology (ICT), ICT integration, ICT tools, mathematics, mathematics teachers, Oshana region, Namibia*

Background of the study

Mathematics is a fundamental subject in the Namibian education system, playing a crucial role in developing skills essential for economic advancement. To achieve Namibia's long-term development goals, as outlined in Vision 2030, the country has undergone socio-economic and educational transformations. A key component of this vision is the integration of Information and Communication Technology (ICT) into education, particularly within Science, Technology, Engineering, and Mathematics (STEM) disciplines.

The Ministry of Education, Arts, and Culture (MoEAC) has been instrumental in realizing this vision through initiatives such as the Education and Training Sector Improvement Programme (ETSIP) (Ngololo, 2010; Chilenje & Mwanza, 2012). Recognizing ICT as a driver of national development, the Ministry of Basic Education, Sports and Culture (2009) emphasized its potential to enhance the delivery of equitable, quality education. In line with ETSIP, the TECH/NA! Project was launched in 2006, equipping 250 senior secondary schools with ICT resources, including servers, thin clients, and wireless switches, between 2008 and 2010. This initiative was complemented by on-site teacher training through the International Computer Driver's License (ICDL) programme, a globally recognized certification designed to develop ICT proficiency (Szyjewski, 2023). However, despite these efforts, not all teachers underwent the training, and little research exists on its effectiveness (Buabeng-Andoh, 2012).

The Namibian ICT Policy prioritizes ICT integration across various educational settings, including secondary schools, teacher education programs, vocational training centres, special needs education, and adult education facilities (Ministry of Basic Education, Sports and Culture, 2009). The policy aims to foster ICT literacy, support innovative teaching and learning, and improve educational management and administration. Furthermore, ICT is expected to enhance students' access to quality education and promote problem-solving, communication, and lifelong learning skills (Das, 2019). Globally, ICT is recognized as an essential tool in modern education, encompassing computers, the Internet, wireless networks, and smart devices (Lobete-Tabata, 2021). Hasan et al. (2016) define ICT as the infrastructure and services required for creating, storing, processing, and sharing information in various formats.

Its integration fosters active learning, student engagement, and innovative teaching methodologies (Oduma & Ile, 2014; Chao,

2015). In mathematics education, ICT has been shown to improve instructional effectiveness by supporting dynamic learning environments and enabling teachers to employ interactive teaching strategies (Guzel, 2011).

However, the effectiveness of ICT integration in mathematics classrooms depends on multiple factors. These include teachers' proficiency in ICT, their attitudes towards its use in instruction, and their beliefs about its impact on students' learning (Das, 2019). According to Baya'a and Daher (2013), teachers' enthusiasm, confidence, and willingness to utilize ICT as a pedagogical tool are critical in determining its success. Despite the recognized benefits, mathematics teachers still face challenges in incorporating ICT into their teaching practices. This study explores the perceptions of mathematics teachers in the Oshana region regarding their use of ICT for teaching and learning, identifying the obstacles they encounter and assessing the extent to which ICT supports mathematics instruction.

Literature review

The integration of ICT in mathematics education has been widely acknowledged for its potential to enhance teaching and learning. However, several challenges hinder its effective utilization by teachers. This section explores the availability of ICT resources, teachers' skills and attitudes, training and support, and the role of professional communities in fostering ICT integration in mathematics instruction. A significant barrier to ICT integration in mathematics classrooms is the lack of access to ICT facilities.

According to Haukongo and Shafuda (2010), many Namibian schools either lack ICT resources or have limited access to them. Even in schools with ICT facilities, mathematics teachers often struggle to incorporate them into their teaching due to resource constraints and infrastructural limitations. ICT tools such as computers, smartphones, laptops, iPads, projectors, and specialized software are essential for effective mathematics instruction, yet they remain unavailable in many schools (Angula et al., 2019).

Studies from other contexts, such as Soma et al. (2021) in Ghana, reveal similar challenges. These researchers emphasized that insufficient ICT infrastructure is a major obstacle for mathematics teachers. They recommended that Ministries of Education invest in graphical calculators, geometric software, and interactive sketching applications to enhance teaching. However, in Namibia, many ICT resources remain permanently fixed in school laboratories or libraries, limiting mathematics teachers' direct access to them (Haukongo & Shafuda, 2010).

For ICT to be effectively utilized in mathematics instruction, teachers must possess the technical skills and confidence to integrate digital tools into their lessons. However, research indicates that many mathematics teachers lack the necessary ICT proficiency (Strom, 2021). This challenge is particularly prevalent among older teachers, who often feel uncomfortable with modern technology and digital learning tools (Johnson et al., 2016). In addition to skills, teachers' attitudes toward ICT significantly impact its integration in the classroom. While some educators view ICT as a valuable tool for enhancing student engagement and problem-solving, others perceive it as time-consuming and difficult to implement (Das, 2019). Without adequate support and motivation, many teachers hesitate to adopt ICT, preferring traditional teaching methods instead.

A crucial factor influencing the use of ICT in mathematics education is the availability of training and professional development programs. Strom (2021) argues that without proper training, teachers lack the confidence to integrate ICT into their lessons. Similarly, Namwandi (2013) highlights that mastering ICT for classroom use requires specialized training in both hardware and software. The International Computer Driver's License (ICDL) program introduced in Namibian schools aimed to provide ICT training, yet many teachers did not participate, and its effectiveness remains uncertain (Buabeng-Andoh, 2012). To address teachers' lack of ICT competence, researchers suggest that ICT training should be embedded into teacher education programs.

According to Murithi and Yoo (2021), teacher training should include ICT as a core component, ensuring that educators graduate with the necessary skills to use technology effectively. However, despite provisions for ICT training through e-learning platforms, ongoing support for teachers remains inadequate. Support from school-based professional communities is essential in helping teachers overcome ICT integration challenges. Agyei and Voogt (2011) argue that fostering collaborative professional networks can help mathematics teachers mitigate issues

such as isolation, lack of time, and limited resources. Providing teachers with mentoring, constructive feedback, and professional motivation can enhance their ability to incorporate ICT into mathematics instruction effectively.

Moreover, school leadership plays a critical role in ICT adoption. Hilton et al. (2015) emphasize that principals and school administrators should offer teachers leadership, training opportunities, and access to ICT resources. Mathematics teachers should also be encouraged to attend workshops, seminars, and collaborative ICT programs to develop their skills further (Namwandi, 2013). Uworwabayeho (2016) highlights key training priorities, including: *Pedagogical integration of ICT in mathematics*, *Familiarity with mathematics-specific software and tools*, *Data-driven instruction*, *Problem-solving and critical thinking using ICT*, and *Blended learning approaches*. While ICT integration has the potential to enhance mathematics education, various studies (Burgos & Godino, 2022; Fuentes-Martinez, 2021; Itter & Meyers, 2017; Posselt, 2018; Senyah, 2024) highlight that teachers often struggle with ICT implementation due to a lack of resources, inadequate training, and limited institutional support. Faced with these challenges, some teachers abandon ICT altogether, reverting to traditional teaching methods (Barakabitze et al., 2019; Mailizar, 2018; Nyawira, 2015; Spangenberg & De Freitas, 2019). However, successful ICT integration depends on addressing context-specific obstacles that mathematics teachers encounter. This study, therefore, sought to investigate mathematics teachers' perceptions of ICT in teaching and learning and assess the extent to which ICT tools are utilized in mathematics instruction.

Methodology

This study employed a qualitative research approach with a descriptive research design to explore the perceptions of mathematics teachers on using ICT in teaching and learning. The qualitative approach was chosen to allow for an in-depth understanding of teachers' experiences, challenges, and strategies in integrating ICT into mathematics instruction. The study was conducted at a secondary school in the Oshana region. The target population consisted of five mathematics teachers, but only four teachers were available and agreed to participate in the study. Purposive sampling was used to select participants based on their experience in teaching mathematics and their exposure to ICT tools in instruction.

Data were collected using in-depth face-to-face interviews with semi-structured questions. This approach enabled participants to express themselves freely, providing detailed insights into their ICT usage and challenges. The interview instrument was developed and validated by the first author with assistance from two ICT teachers to ensure its relevance and clarity. The interview questions included both closed-ended questions, which assessed teachers' ICT skill levels, strategies, types of ICT tools used, and frequency of usage, and, open-ended questions, which explored teaching strategies involving ICT and barriers hindering effective ICT integration in mathematics instruction. Prior to data collection, ethical clearance and site access permission were obtained. Participants provided informed consent, ensuring voluntary participation and confidentiality.

Thematic analysis was employed to analyse the qualitative data, following the three-step approach; the researchers thoroughly read through the interview transcripts, writing memos and annotations on field notes to gain an initial understanding of the data; secondly, emerging ideas and concepts were grouped into themes aligned with the literature review and research objectives, and then, the units of text (such as words, sentences, paragraphs, and quotations) were coded and labelled to identify patterns and meanings within the data.

Results

This section presents the results of the study. Biographical information of participants in terms of gender, age, phase of specialization, and areas of specialization is presented first.

Table 1: Demography of mathematics teachers based on gender and age range

Age range	Male	Female	Total N
21 – 30	0	1	1
31 – 40	1	0	1
40+	2	0	2
Total	**3**	**1**	**4**

The demographic data reveals that 3 out of 4 teachers in the study were male, while only one was a female respondent. One of these male teachers was in the age range of 31-40, while the other two were above the aged of 40. The female mathematics teacher was aged between 21-30 years, as indicated in Table 1. One teacher had less than 5 years of experience teaching mathematics, while the remaining teachers had over 5 years of experience. The teacher in the 31-40 age group had completed a Bachelor of Education Degree in Secondary Education (BEDS) at the University of Namibia, whereas the three teachers aged 40 or older had obtained their education through the Basic Education Teacher Diploma (BETD) at Colleges of Education. The research findings also revealed that teachers who had obtained their BETDs from the Colleges of Education did not receive any ICT training. In contrast, those who completed their studies at higher learning institutions with BEDS did undergo ICT training.

Perceptions of mathematics teachers regarding the utilization of ICT

The participants were asked to indicate whether "Yes" or "No" to items on the teachers' utilization of ICT in the teaching and learning of mathematics in their classrooms (Table 2).

Table 2: Mathematics teachers' perceptions on the utilization of ICT tools

Variables	Yes	No
Teachers were trained to use ICT tools in mathematics.	1	3
No difficulties in operating ICT tools.	1	3
Teachers have no problem with choosing the right ICT tool to use in mathematics	1	3
Integrations of ICT in mathematics reduce time wasting	0	4
There are adequate ICT resources in schools	0	4
There is a computer and a projector in every mathematics classroom.	0	4
There is adequate support and motivation on the usage of ICT tools in mathematics from the school management	1	3
There is an ICT technician in the school to assist the mathematics teachers.	0	4
Computer components e.g., computer mouse, TV remote control, etc. are well taken care of.	1	3
Overcrowded mathematics classrooms	0	4
Short time allocated for mathematics lessons	1	3

In Table 2, three of the four teachers indicated that they did not receive training on how to use ICT in the teaching and learning of mathematics; however, one teacher indicated that he/she had received enough training from a higher education institution. Similarly, three teachers indicated that they found it difficult to choose the right ICT tools and found it difficult to operate the ICT tools, while one indicated that he/she did not find it hard to use ICT tools in the mathematics classroom. All four teachers indicated that integrating ICT in mathematics wasted a lot of time; similarly, all the teachers indicated that there were no adequate ICT resources in schools and there were no computers and a projector in every mathematics classroom. All four respondents indicated that there was no adequate support and motivation for the use of ICT tools in mathematics from the school management; similarly, the school did not have an ICT technician to assist the mathematics teachers whenever they found themselves stuck. Three of the participants indicated that computer components, e.g., computer mouse, TV remote control, and other ICT tools, were not well taken care of, while one of the participants indicated that ICT tools were well taken care of. All four participants indicated that mathematics classrooms were overcrowded. Three of the four participants indicated that the time allocated for mathematics lessons was too short; hence, by the time they finished connecting the ICT tools, the lesson was already over, while one teacher indicated that enough time was allocated for mathematics lessons. It was noticed that teachers perceived that the lack of adequate training, insufficient resources, and poor support from school management hindered the effective integration of ICT tools. Additionally, issues like overcrowded classrooms, inadequate time for

lessons, and the poor condition of ICT components further compounded these challenges.

The level of mathematics teachers' utilization of ICT tools

Teachers were asked to rank how often they used the available ICTs in their classroom instructions. All four teachers indicated that they don't use ICT tools in their classrooms when teaching. Hence, the results revealed that teachers did not utilize ICT tools when teaching mathematics topics in their classrooms.

Competency levels of mathematics teachers to use ICT tools

Table 3 presents the respondents' levels of competency in using ICT tools.

Table 3: Mathematics teachers' ICT competency levels

Level of competence	No. of teachers
Skilled	1
Not Skilled	3
Total	**4**

In Table 3, the data reveals differences in the levels of proficiency among mathematics teachers concerning the utilization of ICT tools for the purpose of teaching mathematics. Specifically, the majority 3 of the four teachers who participated in this study were categorized as not skilled in ICT tool usage in mathematics education. Only one of the participants was identified as proficient in employing ICT tools in their mathematics teaching. The responses from the four mathematics teachers highlighted a potential need for capacity-building initiatives focusing on ICT integration in mathematics education, while also acknowledging the existence of at least one experienced teacher who can potentially serve as a valuable resource and model for others in the enhancement of their ICT skills set for more effective mathematics instruction. The findings revealed that three of the teachers who participated were unskilled in the usage of ICT.

Specific ICT tools found in the school and used by mathematics teachers

Table 4 provides an overview of the Information and Communication Technology (ICT) tools available at the schools and the choices made by mathematics teachers for their classroom instruction use.

Table 4: School ICT tools and teacher preferences

Name of ICT tools available in the school	Number of tools available in the school	Number of teachers prefer using it
Computers	2	1
Internet Fritz box	1	2
Over-Head Projectors	1	-
DLP/LCD/LED/LCOS projectors	2	1
Television (TV)	1	-
DVD players	1	-
Photocopiers	2	4
Printers	1	2

According to the data presented in Table 4, only one of the respondents reported using computers for creating and printing worksheets, while two of the respondents opted for the Internet to access and download worksheets and lesson plan materials. The results revealed that none of the mathematics teachers utilized Over-Head Projectors, TVs, or DVD players in their teaching of mathematics. Two respondents explained that their avoidance of television sets and DVD players stemmed from logistical challenges, such as the need to book these resources in advance, which often resulted in disruptions and chaos within the school. Table 4, shows that all of the respondents relied on photocopy machines to produce sufficient exercise materials, which was a crucial resource due to the shortage of Grade 12 mathematics textbooks. Only one of the mathematics teachers utilized DLP/LCD/LED/LCOS projectors in their mathematics lessons. It was evident from the results in Table 4 that there was a shortage of ICT tools available to mathematics teachers.

Teachers' responses on open-ended interview items

The interviews aimed to gain in-depth insights into the teachers' perceptions regarding the integration of ICT tools in their mathematics classrooms. The teachers' responses are presented as follows:

Researcher: **Briefly comment on your experiences integrating ICT into your mathematics teaching at your school**. *"I only use ICT tools occasionally. It's always difficult to take learners to the computer lab because I need to book the computers or TV in advance and it's frustrating, especially if I find the lab already occupied"* (Teacher 1). "*I don't use ICT in my class therefore I have no experience in using ICT"* (Teacher 2). *"I am well-equipped with ICT skills and I enjoy my lessons. Learners are more interested in mathematics lessons because of the ICT that I use"* (Teacher 3). *"I tried to use ICT in my lesson although I find it difficult to integrate it in my mathematics classrooms"* (Teacher 4).

Researcher: **What types of ICT tools do you use when teaching mathematics?** *"A projector, laptop, and sometimes a TV and DVD player; and I also use the photocopier*" (Teacher 1). *"Photocopier only"* (Teacher 2). *"Projector, photocopier, TV plus DVD and laptop"* (Teacher 3). *"Projector, photocopier, laptop, PowerPoint, TV, and DVD"* (Teacher 4).

Researcher: **What aspects do you consider when integrating ICT into your mathematics classroom?** *"The number of learners, classroom arrangement, and the ICT tools to be used"* (Teacher 1). *"I don't use ICT. Unless the number of copies to be made, ha ha ha ha!"* (Teacher 2). *"Classroom arrangement, ICT tools to be used that day, and group the learners"* (Teacher 3). *"Monitor the concentration of the learners and pay more attention to the slow learners"* (Teacher 4).

Researcher: **What challenges do you face integrating ICT into your mathematics classrooms?** *"There aren't enough ICT tools for all the learners, not enough projectors for all the teachers, and learners sometimes steal the equipment"* (Teacher 1). "S*ince I don't use ICT, I don't have challenges with ICT; unless the photocopier is broken"* (Teacher 2). *"Lack of motivation and encouragement from parents, HOD, principal, and the government. Theft of ICT tools"* (Teacher 3). *"No full access to the ICT tools of the schools, since computers are not enough for the learners in the mathematics class, and learners steal ICT tools such as hard drives, USB devices, mice, and projector cables"* (Teacher 4).

Researcher: **What are your perceptions regarding the integration of ICT in your mathematics classroom?** *"It could be enjoyable if we had training. As it is, it's not user-friendly. At this stage, ICT is complicated to use in mathematics"* (Teacher 1). *"I believe ICT is a waste of time since you will need to connect the ICT tools and it is an embarrassment if one fails to use it in front of learners. Which makes it complicated?"* (Teacher 2). *"I think ICT makes the whole teaching easy, time-saving, and meaningful to the learners. ICT makes learners understand the concepts more than traditional teaching. ICT in education served as a motivational tool for both teachers and students, enabling us to become a part of the technologically advanced global community"* (Teacher 3). *"ICTs are encouraging when we have enough training. The set-up departmental or computer laboratory can be equipped with 45 to 50 computers and a digital projector to train the learners in mathematics"* (Teacher 4).

Discussions

This study revealed several key findings regarding the integration of ICT in mathematics instruction in the Oshana region. One of the most notable findings was that ICT training was more common among teachers with less than five years of experience, whereas teachers with more than five years of experience had not received ICT training during their college education. This gap in training posed a significant challenge to the integration of ICT into mathematics teaching. One of the major challenges identified was the lack of ICT training among mathematics teachers, which aligns with previous studies by Johnson et al. (2016) and Mahmoud (2023). Mahmoud (2023) highlighted that mathematics instruction involves graphical elements such as graphs, tables, and figures, which can be effectively integrated with ICT tools. However, teachers in this study struggled with inserting or creating these components using ICT, thereby limiting its adoption in their lessons. Additionally, many educators expressed feeling overwhelmed and unprepared for ICT integration, further

hindering their willingness to embrace it. A limitation of this study was its small sample size—only four mathematics teachers participated, which significantly restricts the generalizability of the findings. While these teachers' experiences provide valuable insights, they do not necessarily reflect the experiences of the broader teacher population. Furthermore, the study found that ICT training opportunities were scarce, and even among those who received some training, ICT integration in lessons remained minimal due to a lack of ongoing support. These findings are consistent with Haukongo & Shafuda (2010), Soma et al. (2021), and Strom (2021).

Although the teachers expressed a willingness to integrate ICT into their mathematics instruction, they also raised concerns about their ability to operate ICT tools effectively. Many struggled with the use of computers, projectors, and interactive whiteboards, highlighting the need for targeted training and technical support. This challenge suggests that even when ICT resources are available, a lack of technical skills prevents teachers from using them effectively. According to Strom (2021), addressing this issue is critical to ensuring that teachers can fully integrate ICT into their instructional practices, leading to more interactive and engaging learning experiences. Another major challenge was the limited availability of ICT resources in schools. Most resources were restricted to computer laboratories or libraries, rather than being readily accessible in classrooms. This finding supports the research by Onasanya et al. (2011), which highlighted the need for ICT tools to be easily accessible to teachers to optimize curriculum-based activities. Without adequate access, the potential benefits of ICT in mathematics instruction remain largely unrealized. A further obstacle to ICT integration was theft within schools. Teachers reported that students stole ICT resources, including hard drives, USB devices, mice, and projector cables. The ongoing loss of these resources due to inadequate monitoring hampered effective ICT utilization. Schools need better security measures and policies to protect ICT equipment and ensure that teachers have consistent access to the necessary tools for instruction.

The study also found that school management played a crucial role in ICT adoption. A lack of motivation and prioritization of ICT usage by school leadership contributed to teachers' reluctance to embrace ICT. Additionally, the absence of proper monitoring and support systems meant that teachers did not receive adequate encouragement to integrate ICT into their lessons. This aligns with research suggesting that strong leadership and structured support systems are essential for the successful implementation of ICT in education. Finally, overcrowded classrooms were identified as a significant barrier to ICT integration. Most classrooms had 45 or more students, exceeding the ideal maximum of 35 learners per class. With only 40 minutes per lesson, it was impractical to engage all students effectively using ICT tools. This issue, coupled with limited ICT resources, further constrained teachers' ability to implement technology-driven teaching strategies. These findings are consistent with Soma et al. (2021), who also noted that classroom size impacts the feasibility of ICT integration in mathematics instruction.

Conclusion

This study revealed several significant challenges hindering the effective integration of Information and Communication Technology (ICT) in mathematics education. These challenges include insufficient teacher training in ICT, lack of technical skills, inadequate ICT resources, security concerns, lack of administrative support, and overcrowded classrooms. The findings suggest that despite the potential benefits of ICT in enhancing mathematics instruction, its full implementation remains limited in the studied school. While this study provided valuable insights, its small sample size (four participants) limits the generalizability of the findings. Nevertheless, it highlighted the practical struggles teachers face in integrating ICT into their lessons. Notably, three of the four teachers expressed eagerness to incorporate ICT, despite the obstacles encountered. Participants recognized ICT as a motivational tool that enhances teaching, learning, and engagement, positioning both educators and students within a technologically advanced global landscape. For ICT integration to be successful, a holistic approach is required. This includes teacher training programs, improved ICT resource allocation, stronger security measures, and enhanced administrative support.

Recommendations

To enhance the integration of ICT in mathematics education, comprehensive teacher training programs should be implemented. These programs should focus on equipping teachers with both basic and advanced ICT skills, including the use of interactive whiteboards, projectors, and mathematics-specific software such as graphing tools and dynamic geometry applications. Additionally, ongoing mentorship and peer collaboration should be encouraged to support teachers in effectively utilizing ICT in their instruction. The Ministry of Education, higher education institutions, and technology providers should work together to ensure that ICT training is a continuous and structured process, addressing both technical skills and pedagogical strategies for ICT integration in mathematics teaching.

Furthermore, schools should improve ICT infrastructure and accessibility to maximize its adoption. ICT tools should be made readily available in classrooms rather than being confined to computer labs or libraries. Security measures, such as CCTV, lockable storage, and inventory tracking, should be implemented to prevent theft. Additionally, school leadership should prioritize ICT investment, ensuring that teachers have consistent access to the necessary resources. To bridge the gap in ICT availability, partnerships with private organizations, NGOs, and government initiatives should be explored to secure funding for ICT equipment and digital tools.

Future research should investigate how schools are addressing ICT-related challenges and identify best practices for supporting teachers in overcoming these obstacles. By addressing these issues, schools can enhance ICT integration, leading to more effective mathematics instruction and improved learner outcomes.

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