



# Examining the Availability of Information and Communication Technologies in Mathematics Teaching: A Case of the Alfred Nzo East District, South Africa



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## ABSTRACT

The aim of this paper was to examine the availability of Information and Communications Technologies (ICTs) in mathematics teaching in the Alfred Nzo East District, South Africa. The study was guided by the interpretive paradigm, adopting the qualitative research approach in the form of a case study design. The study population consisted of mathematics educators from selected secondary schools. The sample size comprised twelve (12) mathematics teachers from the selected secondary schools. Face-to-face, in-depth semi-structured interviews were conducted using an open-ended interview guide to collect data. Themes derived from participants' responses were thematically analysed. Findings revealed that there is an unavailability of ICT infrastructure, a lack of resources, a lack of professional development, a lack of technical support from the Department of Basic Education (DBE), a lack of ICT workshops for training teachers and the implementation of ICT policies. This research has established an accurate state examining the availability of ICTs in mathematics teaching in the Alfred Nzo East District. It is recommended that the Department of Basic Education (DBE) conducts workshops to train teachers and ensure that ICTs are available in schools. This study contributes to the corpus of current knowledge because of the observed gap.

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## INTRODUCTION

The rapid development of information and communication technologies (ICTs) has brought about significant changes in the twenty-first century and affected the needs of modern communities.<sup>1</sup> The sharing, storing, and administration of various sets of authorized technical tools and resources are all considered ICTs.<sup>2</sup> In recent years, there has been an increase in demand for the use of ICTs in education. Educational institutions are facing growing demands to integrate ICT in order to equip students with the knowledge and skills essential for success in the twenty-first century.<sup>3</sup>

Mathematics, a science-based subject or discipline, is referred to as the "queen of all subjects".<sup>4</sup> Mathematics educators may sometimes lack the necessary comprehension; therefore, they must

<sup>1</sup> Jinsong Wu et al., "Information and Communications Technologies for Sustainable Development Goals: State-of-the-Art, Needs and Perspectives," *IEEE Communications Surveys & Tutorials* 20, no. 3 (2018): 2389–2406.

<sup>2</sup> Alcardo Alex Barakabitze et al., "Transforming African Education Systems in Science, Technology, Engineering, and Mathematics (STEM) Using ICTs: Challenges and Opportunities," *Education Research International* 2019, no. 1 (2019): 6946809.

<sup>3</sup> Laura Icela González-Pérez and María Soledad Ramírez-Montoya, "Components of Education 4.0 in 21st Century Skills Frameworks: Systematic Review," *Sustainability* 14, no. 3 (2022): 1493.

<sup>4</sup> Kaushik Das, "Role of ICT for Better Mathematics Teaching.," *Shanlax International Journal of Education* 7, no. 4 (2019): 19–28.

investigate innovative concepts and technologies that challenge the established theories of mathematics. In the last three decades, there has been a significant rise in advancements within the field of mathematics education.<sup>5</sup> The integration of ICT in mathematics education has the potential to enhance mathematical understanding, promote active learning, and boost student engagement.<sup>6</sup>

The use of ICT in teaching mathematics provides educators with essential tools that help them change their teaching methods, support students in the learning journey, and involve students in exploring new concepts and topics in mathematics. In the modern world, ICTs become indispensable tools for enhancing learning outcomes and creating fruitful teacher-student interactions in the classroom, which now mostly rely on ICT integration.<sup>7</sup> The use of ICTs will help improve education in all geographical areas, particularly rural schools, and will enable rural students to compete on the same level as urban students. However, the Department of Basic Education's implementation of the e-Education policy in rural schools in the Eastern Cape has been impeded by a lack of infrastructure, digitally illiterate teachers, and limited access to resources.

A study by Eickelmann et al. explored an analysis in utilizing the Trends in International Mathematics and Science Study (TIMSS) 2007 data and a multi-level methodology to investigate the relationship between mathematical achievement and the usage of ICT in primary school mathematics teaching.<sup>8</sup> There are long-term negative correlations between different forms of ICT use and mathematics achievement after adjusting for pupils' socioeconomic situation. However, there are chronological impediments in the utilisation of ICTs in mathematics teaching. These include the lack of available ICT tools and resources, mathematics teachers' attitudes towards the use of ICTs, inadequate infrastructure, and digitally illiterate teachers.

The limited access to resources has a negative impact on integrating ICTs for learners in rural schools, as it leads to lower engagement and learner motivation, the skills development is reduced, and the inadequate ICT integration restricts learners' access to online learning material and educational videos that could enhance their understanding of the subject and provide a broader perspective beyond the textbooks recommended. ICTs can affect learners' mathematics achievement if they are used properly.

A study conducted by Ndlovu et al. in South Africa, it revealed that in order to effectively use ICTs to impact learner achievement, preservice teachers identified the following crucial elements: mathematics teachers must adapt to the demands and challenges of the digital era; they must believe in a changing identity for mathematics teachers; they must process strong ICT-related competencies; and there must be sufficient resources and careful planning. However, teachers' perceptions concerning ICT use in the classroom have institutional factors that influence them, such as a lack of infrastructure, a lack of ICT tools and digitally illiterate teachers. There should be ICT coordinators based in schools, and teachers should receive training specific to their individual needs on how to use ICTs in teaching.<sup>9</sup>

Mathematics is one of the subjects taught in schools that helps learners develop their critical thinking skills. The use of graphing calculators, online resources, and interactive whiteboards (IWBs) is crucial in establishing a dynamic learning environment.<sup>10</sup> It is notable that ICTs have an impactful role in modern education by enhancing accessibility and interactivity in teachers' competencies, attitudes, and beliefs in their decision-making in the classroom. The traditional teaching approach, in which knowledge is mostly imparted through lessons and textbooks, frequently relies on direct instruction. This method tends to prioritise passive learning and rote memorisation, which reduces opportunities for learner participation and critical thinking.

<sup>5</sup> Katja Maass et al., "The Role of Mathematics in Interdisciplinary STEM Education," *Zdm* 51, no. 6 (2019): 869–84.

<sup>6</sup> Muhammad Sher Baz Ali, Razia Yasmeen, and Zeeshan Munawar, "The Impact of Technology Integration on Student Engagement and Achievement in Mathematics Education: A Systematic Review," *International Journal of Computer Integrated Manufacturing* 6, no. 3 (2023): 222–32.

<sup>7</sup> Ashish Kumar et al., *AI-Assisted Special Education for Students with Exceptional Needs* (IGI Global, 2023).

<sup>8</sup> Birgit Eickelmann et al., "ICT-Use in Primary Schools and Children's Mathematics Achievement-a Multi-Level Approach to Compare Educational Systems through an International Lens with TIMSS Data," in *Joint AARE APERA International Conference, WERA Focal Meeting, Sydney*, vol. 2012, 2012.

<sup>9</sup> Mdutshekela Ndlovu et al., "Preservice Teachers' Beliefs and Intentions about Integrating Mathematics Teaching and Learning ICTs in Their Classrooms," *ZDM* 52, no. 7 (December 24, 2020): 1365–80, <https://doi.org/10.1007/s11858-020-01186-2>.

<sup>10</sup> F M Mwaniki, F K Nyamu, and M M Waititu, "An Exploration of the Integration of Ict in Mathematics Lessons in Secondary Schools, Garissa County, Kenya," *Journal of Education* 4, no. 1 (2024): 12–22.

This study sought to examine the availability of Information and Communication Technologies in Mathematics Teaching in selected secondary schools in the Alfred Nzo East District in the Eastern Cape. Researchers have stated that the state of rural school being neglected and highlighted that there is a lack of adequate infrastructure, lack of ICT resources, and lack of technical support from the Department of Basic Education (DBE). However, it is important to take note of the policies that have been placed by the DBE, such as White Paper 7 e-Education Policy.

This paper addresses the availability of ICTs in mathematics teaching in the Alfred Nzo East District. In the Alfred Nzo East District, teachers were included in the study, and through interviews, their viewpoints were acquired, which helped form the findings. The results of this study may help guide future research projects.

## LITERATURE REVIEW

### The Availability of ICTs in Mathematics Teaching

A study conducted by Bray and Tangney in Ireland found that digital technology integration in mathematics education has the potential to address many problems as it provides students with a variety of avenues to construct and interact with mathematical knowledge, place the subject in real-world settings, and afford them the agency to give their learning meaning.<sup>11</sup> The importance of utilising ICTs to enhance the mathematics teaching process enables both teachers and learners to have unlimited access to global data and information.

A study conducted by Viberg et al. in Sweden explored three crucial elements that are identified as being connected to the successful integration of technology into mathematics education: the role of the teacher, the education setting, and the design of the technology, learning tasks, and activities, in order to transform mathematical practice through the use of digital technologies.<sup>12</sup> In addition, it is important that mathematics teachers are involved in the transformative process as co-designers and teacher researchers.

In Kenya, Garissa County, ICT integration in teaching mathematics is employed in various ways, and educational programmes have incorporated ICTs over the years. According to Shi et al. 2021, the most popular technique for integrating ICT was using interactive whiteboard (IWB) materials and PowerPoint presentations. A study conducted by Phiri in Zambia found that the teachers acknowledged the importance of teaching mathematics using ICTs.<sup>13</sup> However, the lack of ICT facilities, the lack of internet access, and the high cost of procuring and maintaining ICT tools hamper the teaching of mathematics in Zambia.

In South Africa, Chigona investigated how educators were using ICT to enhance mathematics teaching.<sup>14</sup> Graphing calculators, online resources, and IWBs are all crucial in establishing a dynamic learning environment. Lessons are given new life by the IWBs, which add visually appealing features that draw in learners. However, inadequate preparation of teachers, limited access to ICT resources, and a persistent reluctance to stray from conventional teaching techniques still continue.

Even though ICTs improve teaching, the majority of facilities in Eastern Cape Schools are currently not being used by teachers and learners for the intended purpose.<sup>15</sup> Bariu assert that most ICTs resources are not sufficiently accessible in schools.<sup>16</sup> This suggests that even if teachers are qualified

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<sup>11</sup> Aibhín Bray and Brendan Tangney, "Technology Usage in Mathematics Education Research—A Systematic Review of Recent Trends," *Computers & Education* 114 (2017): 255–73.

<sup>12</sup> Olga Viberg, Åke Grönlund, and Annika Andersson, "Integrating Digital Technology in Mathematics Education: A Swedish Case Study," *Interactive Learning Environments* 31, no. 1 (2023): 232–43.

<sup>13</sup> William Phiri, "Pupils' and Teachers' Perception toward the Use of Information and Communication Technology (ICT) in the Teaching and Learning of Mathematics in Selected Secondary Schools of Central Province, Zambia," *International Journal of Multidisciplinary Research and Development* 3, no. 1 (2016): 77–87.

<sup>14</sup> Agnes Chigona, "Digital Fluency: Necessary Competence for Teaching and Learning in Connected Classrooms," *The African Journal of Information Systems* 10, no. 4 (2018): 7.

<sup>15</sup> OA Ojo and EO Adu, "The Effectiveness of Information and Communication Technologies (ICTs) in Teaching and Learning in High Schools in Eastern Cape Province," *South African Journal of Education* 38, no. Supplement 2 (December 31, 2018): 1–11, <https://doi.org/10.15700/saje.v38ns2a1483>.

<sup>16</sup> Timothy Ntorukiri Bariu, "Status of ICT Infrastructure Used in Teaching and Learning in Secondary Schools in Meru County, Kenya," *European Journal of Interactive Multimedia and Education* 1, no. 1 (2020): e02002.

and eager to share their knowledge with learners, they cannot do so because of a lack of technology resources and computer laboratory space.

## THEORETICAL FRAMEWORK

The study was guided by the Technological Pedagogical Content Knowledge (TPACK) theory by Mishra and Koehler, as it addresses the complex, multifaceted, and contextual characteristics of teacher knowledge while attempting to determine the type of information needed by teachers to integrate technology into their lessons.<sup>17</sup> The TPACK framework outlines how teachers can successfully implement technology-based teaching and learning by integrating it with pedagogy and subject-matter expertise. Bakar et. al. state that TPACK demonstrates how teachers can use technology to enhance their teaching.<sup>18</sup> The TPACK framework specifies the technology integration and knowledge required to achieve the desired outcomes.

The complex connections among the three primary categories of knowledge—content knowledge (CK), pedagogy knowledge (PK), and technology knowledge (TK)—are the fundamental elements of the TPACK framework. By emphasizing the types of knowledge that lie at the intersection of the three primary forms of Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK), the TPACK methodology goes beyond taking into account each of these three knowledge bases independently.<sup>19</sup>

Each situation is unique, and no single combination of content, technology, and pedagogy will apply to every teacher, every course, or every teaching approach, according to this theory, which also takes into account factors like culture, demography, grade level, individual teachers, and school-specific circumstances. In order to improve learning outcomes and make sure that the components are successfully blended when used to teach mathematics, teachers might benefit from the TPACK theory.

## METHODOLOGY

This study was guided by the interpretivism paradigm and adopted the qualitative research approach in the form of a case study design as it sought to examine the availability of ICTs in mathematics teaching. Qualitative research approach starts by focusing on events that occur now or have occurred in the past in a natural environment, or in the real world, and they require careful collection and study of the complexity of the phenomena.<sup>20</sup> A qualitative research approach collects data under specific conditions using a systematic process and procedures, then uses data analysis to emphasise findings objectively. Furthermore, the qualitative research method allows data to be gathered from the participants in the form of words pertaining to their experiences or perceptions.<sup>21</sup>

The researcher employed an intrinsic collective case study design. A case study is a form of qualitative research where the goal is to give a thorough description of the traits and dynamics seen in one or more cases.<sup>22</sup> Examining the availability of ICTs in mathematics teaching in the Alfred Nzo East District, a case study was employed. The target population for this study were mathematic teachers in the Alfred Nzo East District.

The participants were informed of the study's aim and permission to have their responses have to be voice recorded was requested by the researcher. Twelve participants from the selected secondary schools participated in fruitful face-to-face interviews conducted by the researcher. Numerous benefits are exposed by interviews. Since the intention was to examine the availability of ICTs in mathematics teaching, the interviews were suitable for the study. The researcher informed the participants of the

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<sup>17</sup> Punya Mishra and Matthew J Koehler, "Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge," *Teachers College Record* 108, no. 6 (2006): 1017–54.

<sup>18</sup> Nurul Shahhida Abu Bakar, Siti Mistima Maat, and Roslinda Rosli, "Mathematics Teacher's Self-Efficacy of Technology Integration and Technological Pedagogical Content Knowledge.," *Journal on Mathematics Education* 11, no. 2 (2020): 259–76.

<sup>19</sup> M.J. Koehler and P. Mishra, "TPACK (Technological Pedagogical Content Knowledge)," in *The SAGE Encyclopedia of Educational Technology*, ed. Matthew J. Koehler and Punya Mishra (Thousand Oaks, CA: Sage Publications, Inc., 2015), 783–88.

<sup>20</sup> Paul D. Leedy and Jeanne Ellis. Ormrod, *Practical Research : Planning and Design* (Pearson, 2016).

<sup>21</sup> D.J. Brynard, S.K. Hanekom, and P.A. Byrnard, *Introduction to Research*, 3rd ed. ( Pretoria: Van Schaik, 2014).

<sup>22</sup> R.B. Johnson and L. B. Christensen, *Educational Research: Quantitative, Qualitative, and Mixed Approaches*, 7th ed. (Thousand Oaks, California: SAGE, 2019).

study's aim and permission to have their responses voice-recorded and guaranteed that records and reports of all the participants would be anonymous and confidential.

In-depth face-to-face interviews to gain in-depth opinions of the study were employed. Semi-structured interviews were conducted to allow participants to express their school experiences while also allowing the researcher to follow the participants' interests and opinions. The purposive sampling technique was used to select twelve teachers from the selected secondary schools. Purposive sampling is the process by which a researcher establishes the attributes of the intended audience and searches for participants who meet those requirements.<sup>23</sup>

A non-discriminatory research instrument against any participant was validated by the researcher, notifying all will be asked the same questions. The researcher sought out permission from the Department of Basic Education (DBE) and school principals to conduct research at the selected secondary schools. Furthermore, the researcher issued informed consent to the participants, ensuring that their welfare and rights will not be violated, and all will be respected and kept private.

## PRESENTATION OF FINDINGS

The analysis of the responses to each question, as well as the excerpts and examples from participants, is presented as follows:

### Question 1:

#### **What do you think is the role of Information and Communication Technologies (ICTs) in mathematics teaching?**

All twelve participants (100%) stated that the role of Information and Communication Technologies in mathematics teaching is exceedingly important as it promotes learning to rigorous standards, and learners can work independently in the classroom. Most teachers use laptops and computers to assist in setting question papers for all forms of assessments, acquiring and sharing information from the internet to be used in the classroom and which can be shared digitally using smart cell phones. The above statement is supported by the following responses:

**Respondent 1 (Teacher):** *ICTs play a critical role in mathematics as they are a fundamental tool to advance the Fourth Industrial Revolution. It also helps the advancement of teaching and learning, which helps a better and easier understanding of Mathematics, with intentions that a learner may be capacitated without any restrictions to information.*

**Respondent 2 (Teacher):** *ICTs in Mathematics teaching benefit both the learner and the teacher. Learners have different styles and abilities; others learn by video tutorials, games, software, puzzles, etc. It also helps teachers to plan their lessons according to the learner's abilities, needs and styles, and it also offers teachers opportunities for professional and technological growth.*

**Respondent 8 (Teacher):** *The role of ICTs in teaching Mathematics will help speed up the teaching process, and the use of visuals will help the learners advance their learning capacity.*

**Respondent 10 (Teacher):** *ICT in teaching mathematics is important as it can provide us, mathematics teachers, with various ways to deliver the content to learners, assess learners in various ways and improve teacher knowledge and pedagogy through the use of different mathematics software applications that are available for the subject.*

### Question 2:

#### **Why do you use or not use ICTs in teaching mathematics?**

Four participants (33%) of the participants expressed their ways of using Information and Communication Technologies in teaching mathematics in the classroom. The teachers use computers and laptops to assist them in gathering information from the internet and setting formal assessment tasks such as tests and examinations. The above statement is supported by the following responses:

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<sup>23</sup> John W Creswell and J David Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (Sage publications, 2017).

**Respondent 3 (Teacher):** *I use ICTs in teaching mathematics to make engagement with learners conducive and to get them fully equipped with technological capabilities in their learning environment. ICT also helps learners to have a creative knowledge and be broad-minded when dealing with critical thinking.*

**Respondent 4 (Teacher):** *I use ICTs in teaching mathematics because it helps me gain skills in teaching mathematics in order to make learners easily understand the concepts, it promotes electronic learning, and also, I am able to track the learners' progress and provide instant feedback to learners.*

**Respondent 6 (Teacher):** *I use ICTs to download information and past question papers from the internet, and there's no time wasted to access and sharing the study material with the learners in class electronically.*

**Respondent 7 (Teacher):** *I use a computer to do lesson plan preparation, download information and mathematics videos to use in the classroom for a particular topic, and set formal tasks.*

Eight participants (67%) stated that they do not use ICTs in mathematics teaching in the classroom. This is supported by the following responses:

**Respondent 5 (Teacher):** *I do not use ICTs for teaching mathematics because I am not trained in how to use ICT tools and have no experience in using a computer.*

**Respondent 8 (Teacher):** *I do not use ICTs because of a lack of knowledge of how to use them for teaching.*

**Respondent 9 (Teacher):** *I do not use ICTs in teaching mathematics as I teach in a rural school, where there is a lack of ICT facilities and equipment, and we have electricity and network issues, so using ICTs would be time-consuming.*

### **Question 3:**

#### **Which ICTs are available in your school for teaching?**

All twelve participants (100%) said their schools have ICTs available on site in the form of tablets, overhead projectors, printers, and laptops, and there is WI-FI connectivity as the schools have been provided with routers and data for internet connection by the Department of Basic Education. However, there is a lack of ICT infrastructure facilities and computer laboratories. The above is supported by the following responses:

**Respondent 2 (Teacher):** *ICTs that are available in my institution are tablets, overhead projectors, a Wi-Fi router and laptops.*

**Respondent 3 (Teacher):** *We have limited computers, projectors, and a Wi-Fi router for internet connection to access the internet for information.*

**Respondent 11 (Teacher):** *The school has WI-FI connectivity installed and has been supplied with a wireless projector and the latest version of Lenovo tablets for teaching purposes in the classroom.*

**Respondent 12 (Teacher):** *There is a computer lab in this school with twenty-eight computers, tablets, projectors, and internet connectivity using a Wi-Fi router supplied to the school by the Department of Education.*

### **Question 4:**

#### **What can the Department of Basic Education (DBE) do to provide the means to assist with ICTs in your school?**

All twelve participants (100%) highlighted that the schools will benefit if the Department of Basic Education can provide the means to assist with ICTs for teaching in schools and implement the ICT policy, train teachers how to use the computers, have adequate infrastructures available, and have the necessary equipment available for conducive engagement in a classroom environment. The above is supported by the comments below:

**Respondent 4 (Teacher):** *The Department of Education can develop strategies and a framework for ICT implementation, delivery of ICT infrastructure and internet access to all schools, provide technical support, equipment, and provide incentives to encourage teachers to use ICTs in their daily work.*

**Respondent 5 (Teacher):** *The Department of Education may help in providing the teachers with training and workshops for digital literacy, ensure that all schools have reliable internet connectivity, and ensure that all schools have computer labs and up-to-date hardware and software.*

**Respondent 8 (Teacher):** *Build the necessary infrastructure and assist teachers by providing them with training in how to use ICTs and teach them about the programs that are user-friendly for teaching mathematics.*

**Respondent 9 (Teacher):** *The Department of Education must assist schools to switch from using chalkboards to whiteboards, as this modern way of teaching can create interest in learners, and also saves time during teaching and learning.*

#### **Question 5:**

##### **What is your concern about educators' resistance to accepting the use of ICTs in teaching?**

Ten of the participants (83%) said that resistance to change by teachers is very high, as they raise a fear of using ICTs for teaching due to a lack of technological exposure when they pursued their teaching careers. The lack of ICT knowledge and skills amongst teachers is a contributing factor in accepting the use of ICTs in teaching, and some educators stated that the use of technology may cause distraction to their learners, as it would be something new to them. This comment is supported by excerpts below:

**Respondent 1 (Teacher):** *It derails progress, especially for learners, because they are stuck in primitive learning methods, resulting in the learner struggling when they get to tertiary education and the working environment.*

**Respondent 4 (Teacher):** *The development of quality education is delayed, and we as educators resist accepting new technology, and we as educators fear that technology can distract a learner rather than having them fully engaged in the lesson while using ICT gadgets in class.*

**Respondent 7 (Teacher):** *Educators' resistance to using ICTs can deprive learners of access to adequate digital learning. Educators will not stay updated with new best practices of using technology in teaching due to resistance to adopting the use of ICTs and applying only the traditional methods of teaching.*

**Respondent 12 (Teacher):** *Not accepting the use of ICTs in teaching is caused by being scared of making mistakes using ICTs and poverty in pedagogy, thus resulting in resisting change.*

Two of the participants (17%) indicated that accepting the use of technology in teaching helps develop learners to excel in their studies. They also highlighted that, regardless of the lack of technological pedagogy, teachers can develop themselves by using digital platforms, such as watching videos on YouTube without paying a tuition fee. The comment is supported by the excerpts below:

**Respondent 3 (Teacher):** *I have accepted the use of ICTs in the teaching space as I continuously learn how to advance my technological skill by the help of watching online videos on YouTube and sharing the latest information and skills with colleagues and learners.*

**Respondent 6 (Teacher):** *Resistance to adopting the use of ICTs does not develop anyone but an impediment to one's self-development, and that, for things in life, you do not need your superiors to be involved in the development of your skills and knowledge.*

## **DISCUSSION**

The research findings revealed that the role of Information and Communication Technologies in mathematics teaching can help enhance the quality of education in schools. According to Alabdulaziz, the use of technology in mathematics teaching gives the learner a broader platform to learn from the internet, to be able to use any digital device, whether it is a tablet or a computer, as a source of communication and presentation of work, and to be independent of the teachers.<sup>24</sup> ICTs are crucial for accomplishing general socioeconomic objectives in social development, work, healthcare, and education.

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<sup>24</sup> Mansour Saleh Alabdulaziz, "COVID-19 and the Use of Digital Technology in Mathematics Education," *Education and Information Technologies* 26, no. 6 (2021): 7609–33.

Perienen highlights that teaching has benefited from the use of ICT in mathematics education, and the research examined indicates greater teacher effectiveness and confidence in their abilities to teach mathematics, as well as better student engagement, motivation, and achievement in the mathematics subject.<sup>25</sup> It is crucial to note that teachers must learn to adapt to the changes in order to meet the demands of the twenty-first century, especially with regard to the emerging trends in teaching that use ICTs.

The access to adequate infrastructure and the lack of ICT resources impede the use of ICTs in teaching mathematics. ICT infrastructure is insufficient in the Eastern Cape; only Computer Application Technology (CAT) learners are taught computer skills in some schools with facilities.<sup>26</sup> The majority of teachers revealed that they do not use ICTs, and the minority of teachers use computers and laptops to assist them in gathering information from the internet, preparing lesson plans and question papers for assessments.

According to Tariq, computers are used by teachers to plan classes and content, create documents, create presentations, and administer examinations.<sup>27</sup> The significant functions of ICTs in teaching are that they allow opportunities for learners to express their skills and enhance their creativity while interacting with the teacher. ICT in the educational setting facilitates the development of 21<sup>st</sup> century abilities in students, although this is dependent on the teachers' level of digital literacy.<sup>28</sup> Examining the availability of the use of ICTs in mathematics teaching transforms the traditional approach to teaching and provides new opportunities.

Mavellas et al. posit that ICT resources are not sufficiently accessible in schools due to the lack of infrastructure.<sup>29</sup> The schools may have limited ICT resources provided, and the lack of infrastructure limits educational activities in utilising these resources. In rural schools, the availability of ICT resources is inadequate. With the exception of laptops, tablets, projectors, and Wi-Fi routers, there are not many ICT tools available for effective instructional delivery. Access to ICT tools is a crucial component of ICT integration in education, and in low-income communities, access to ICT tools may be limited due to poverty and a lack of infrastructure.<sup>30</sup>

Schools in rural areas are less empowered when compared to schools in urban areas. Priority should be given to strategies and solutions that emphasise teachers' effective use of ICT as a crucial instrument to assist instruction and provide rural schools with the necessary ICT infrastructure. The availability and use of ICT resources are critical for a successful integration of technology in schools.<sup>31</sup> The availability of ICT resources in urban areas is functional, and it continuously develops as schools are increasingly being technologically resourced with computer facilities for teaching. The study exposed that though little attempts have been made to equip schools with ICT resources such as tablets, Wi-Fi routers, overhead projectors and printers, the Department of Basic Education needs to facilitate ICT training for teachers and administer the implementation of e-education policies.

The flow of working when utilising ICTs is faster than traditional pedagogy, and it saves time. The study exposed that ICTs offer more opportunities to advance critical thinking skills, a creative learning environment is produced, and quality education is delivered. The benefits of utilising ICTs in education are to encourage collaborations that enable teachers to exchange useful technological techniques and insights, provide opportunities for instructors who use technology to be virtually

<sup>25</sup> Appavoo Perienen, "Frameworks for ICT Integration in Mathematics Education-A Teacher's Perspective," *Eurasia Journal of Mathematics, Science and Technology Education* 16, no. 6 (2020): em1845.

<sup>26</sup> Grasia Chisango et al., "Teachers' Perceptions of Adopting Information and Communication Technologies in Teaching and Learning at Rural Secondary Schools in Eastern Cape, South Africa," *Africa Education Review* 17, no. 2 (March 3, 2020): 1–19, <https://doi.org/10.1080/18146627.2018.1491317>.

<sup>27</sup> M. Tariq, "10 Uses of Computers in Education," *Educate Computer*, 2024.

<sup>28</sup> Julius Murithi and Jin Eun Yoo, "Teachers' Use of ICT in Implementing the Competency-Based Curriculum in Kenyan Public Primary Schools," *Innovation and Education* 3, no. 1 (2021): 1–11.

<sup>29</sup> Sibanda Mavellas, Mapenduka Wellington, and Furusa Samuel, "Assessment of the Availability and Utilization of ICTs for Teaching and Learning in Secondary Schools-Case of a High School in Kwekwe, Zimbabwe," *International Journal of Scientific & Technology Research* 4, no. 8 (2015): 282–88.

<sup>30</sup> S. Asare et al., "The Role of ICT in Teaching and Learning Mathematics at College of Education: A Systematic Review," *Journal of Education and Practice* 14, no. 2 (April 2023), <https://doi.org/10.7176/JEP/14-12-06>.

<sup>31</sup> Shedrack Tamunoiyowuna, "Availability and Use of ICT Materials in Teaching and Learning of Physics among Senior Secondary Students in Obio-Akpor Local Government Area of Rivers State, Nigeria," 2022.

observed, add technology-enhanced resources to the curriculum, and allow teachers to choose and cover curriculum materials with enough freedom.<sup>32</sup> However, there is a lack of ICT integration in rural schools due to the non-availability of infrastructure and nonavailability of adequate ICT resources.

Rural schools are neglected by the government, stakeholders, and the Department of Basic Education in establishing computer facilities. The study exposed factors such as age, lack of incentives, lack of professional development, lack of technical support, and lack of knowledge and skills that hinder the utilization of ICTs in mathematics teaching. According to García et al. factors such as age, gender, and teaching experience are amongst the influencing factors of the use of mathematical software in teaching.<sup>33</sup>

With the current transformation of urban schools being more digitally advanced with accessible infrastructure and resources, the rural schools are yet to be provided with adequate ICT facilities and resources to integrate into their classrooms. The lack of time and effective training, lack of accessibility and lack of infrastructure, lack of technical support and access to the internet, and resistance to change and negative attitudes are the contributing factors that hinder ICT integration in schools.<sup>34</sup> The attitudes, beliefs, and opinions of teachers have a big influence on whether or not they are willing to adopt and employ ICT tools in the classroom.<sup>35</sup>

Using ICTs requires skills and knowledge about the hardware and software needed for mathematics teaching, having access to ICT infrastructure, and being digitally literate. According to Marbán and Mulenga, the adoption of ICTs in mathematics education may be hindered by the resistance of teachers to change, which would lessen the potential advantages of technology.<sup>36</sup> The lack of technological knowledge leads to resistance and unwillingness to accept the use of ICTs in the classroom. Teachers may be unwilling to utilise ICTs in the classroom due to a lack of familiarity with technology.

## RECOMMENDATIONS

Teachers need to acknowledge that at their disposal they have access to information through the use of their smartphones, tablets, etc. The Department of Basic Education must instill a culture of ICT integration into teaching through intensive training workshops where teachers will learn how to incorporate ICTs into their pedagogical activities. Immediate plans should be devised to remedy the unsatisfactory infrastructure in schools. The Department of Basic Education must guarantee that every school in the country has accessible ICT infrastructure on the premises, thereby ensuring that every community has equal access to technology.

The DBE must further empower all teachers to undergo compulsory training in the basic uses of ICT resources, such as the use of a computer and software. Furthermore, the DBE needs to go above and beyond basic requirements by empowering and assisting every rural school with adequate, high-quality, equipped computer laboratories with the most recent computer hardware and software, reliable internet connection, technical support staff for a conducive learning environment, and administrative support.

In orders for schools to acquire IWBs, projectors, Wi-Fi connectivity, educational mathematics software programs such as Maxima, which is an algebra solver software, and GeoGebra, an advanced mathematics software program which works for most topics in the mathematics syllabus, and hand-held devices that will provide teachers with ongoing learner assessments and immediate reports in correlation with the curriculum, they must be prepared to integrate ICT into teaching and learning.

<sup>32</sup> Japhet E Lawrence and Usman A Tar, "Factors That Influence Teachers' Adoption and Integration of ICT in Teaching/Learning Process," *Educational Media International* 55, no. 1 (2018): 79–105.

<sup>33</sup> T. García and M. Lladó, "Teacher Preparation in a Global Context: A Comparative Analysis of Stakeholder Perspectives," *Teaching and Teacher Education* 92 (2020): 103010.

<sup>34</sup> Kesh Rana and Karna Rana, "ICT Integration in Teaching and Learning Activities in Higher Education: A Case Study of Nepal's Teacher Education.," *Malaysian Online Journal of Educational Technology* 8, no. 1 (2020): 36–47.

<sup>35</sup> Jacob Arhin et al., "Perceptions and Readiness of High School Mathematics Teachers for Integration of ICT Tools in the Teaching and Learning of Mathematics.," *Pedagogical Research* 9, no. 1 (2024).

<sup>36</sup> José M Marbán and Eddie M Mulenga, "Pre-Service Primary Teachers' Teaching Styles and Attitudes towards the Use of Technology in Mathematics Classrooms.," *International Electronic Journal of Mathematics Education* 14, no. 2 (2019): 253–63.

## CONCLUSION

This paper sought to examine the availability of Information and Communications Technologies (ICTs) in mathematics teaching in the Alfred Nzo East District, South Africa. The findings have shown that the rural schools of the Alfred Nzo East District lack adequate infrastructure and ICT resources to improve the quality of education. Teachers lack technological pedagogical content knowledge concerning the use of ICTs in teaching mathematics. Professional development, as a matter of urgency, needs to be conducted in order to have teachers gain a greater interest in using ICTs in teaching. Adequate ICT infrastructure, tools and resources should be provided to improve the standard of content delivery.

From the findings, it is evident that the teachers' ability to integrate ICTs in the classroom is inadequate. Based on the above-mentioned, digital training was not taken into consideration. It is hoped that the non-availability of ICT resources and the challenges faced by schools and teachers, in the discussed findings, will be taken cognisance of by all the relevant stakeholders. The Department of Basic Education (DBE) must therefore conduct workshops to train teachers and ensure that ICTs are available in schools.

## BIBLIOGRAPHY

- Alabdulaziz, Mansour Saleh. "COVID-19 and the Use of Digital Technology in Mathematics Education." *Education and Information Technologies* 26, no. 6 (2021): 7609–33.
- Ali, Muhammad Sher Baz, Razia Yasmeen, and Zeeshan Munawar. "The Impact of Technology Integration on Student Engagement and Achievement in Mathematics Education: A Systematic Review." *International Journal of Computer Integrated Manufacturing* 6, no. 3 (2023): 222–32.
- Arhin, Jacob, Francis Ohene Boateng, Ernest Frimpong Akosah, and Kennedy Gyimah. "Perceptions and Readiness of High School Mathematics Teachers for Integration of ICT Tools in the Teaching and Learning of Mathematics." *Pedagogical Research* 9, no. 1 (2024).
- Asare, S., K.D. Agyeman, J. Nyarko, N. Opoku-Mensah, M.O. Fokuo, Caroline Owusu-Mintah, and R. Asamoah. "The Role of ICT in Teaching and Learning Mathematics at College of Education: A Systematic Review." *Journal of Education and Practice* 14, no. 2 (April 2023). <https://doi.org/10.7176/JEP/14-12-06>.
- Bakar, Nurul Shahhida Abu, Siti Mistima Maat, and Roslinda Rosli. "Mathematics Teacher's Self-Efficacy of Technology Integration and Technological Pedagogical Content Knowledge." *Journal on Mathematics Education* 11, no. 2 (2020): 259–76.
- Barakabitze, Alcardo Alex, Anangisye William-Andey Lazaro, Neterindwa Ainea, Michael Hamza Mkwizu, Hellen Maziku, Alex Xavery Matofali, Aziza Iddi, and Camillius Sanga. "Transforming African Education Systems in Science, Technology, Engineering, and Mathematics (STEM) Using ICTs: Challenges and Opportunities." *Education Research International* 2019, no. 1 (2019): 6946809.
- Bariu, Timothy Ntorukiri. "Status of ICT Infrastructure Used in Teaching and Learning in Secondary Schools in Meru County, Kenya." *European Journal of Interactive Multimedia and Education* 1, no. 1 (2020): e02002.
- Bray, Aibhín, and Brendan Tangney. "Technology Usage in Mathematics Education Research—A Systematic Review of Recent Trends." *Computers & Education* 114 (2017): 255–73.
- Brynard, D.J., S.K. Hanekom, and P.A. Byrnard. *Introduction to Research*. 3rd ed. Pretoria: Van Schaik, 2014.
- Chigona, Agnes. "Digital Fluency: Necessary Competence for Teaching and Learning in Connected Classrooms." *The African Journal of Information Systems* 10, no. 4 (2018): 7.
- Chisango, Grasia, Newlin Marongwe, Nomxolisi Mtsi, and Thembisile E. Matyedi. "Teachers' Perceptions of Adopting Information and Communication Technologies in Teaching and Learning at Rural Secondary Schools in Eastern Cape, South Africa." *Africa Education Review* 17, no. 2 (March 3, 2020): 1–19. <https://doi.org/10.1080/18146627.2018.1491317>.
- Creswell, John W, and J David Creswell. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage publications, 2017.
- Das, Kaushik. "Role of ICT for Better Mathematics Teaching." *Shanlax International Journal of Education* 7, no. 4 (2019): 19–28.

- Eickelmann, Birgit, Kerstin Drossel, Heike Wendt, and Wilfried Bos. "ICT-Use in Primary Schools and Children's Mathematics Achievement-a Multi-Level Approach to Compare Educational Systems through an International Lens with TIMSS Data." In *Joint AARE APERA International Conference, WERA Focal Meeting, Sydney*, Vol. 2012, 2012.
- García, T., and M. Lladó. "Teacher Preparation in a Global Context: A Comparative Analysis of Stakeholder Perspectives." *Teaching and Teacher Education* 92 (2020): 103010.
- González-Pérez, Laura Icela, and María Soledad Ramírez-Montoya. "Components of Education 4.0 in 21st Century Skills Frameworks: Systematic Review." *Sustainability* 14, no. 3 (2022): 1493.
- Johnson, R.B., and L. B. Christensen. *Educational Research: Quantitative, Qualitative, and Mixed Approaches*. 7th ed. Thousand Oaks, California: SAGE, 2019.
- Koehler, M.J., and P. Mishra. "TPACK (Technological Pedagogical Content Knowledge)." In *The SAGE Encyclopedia of Educational Technology*, edited by Matthew J. Koehler and Punya Mishra, 783–88. Thousand Oaks, CA: Sage Publications, Inc., 2015.
- Kumar, Ashish, Anand Nayyar, Rohit Kumar Sachan, and Rachna Jain. *AI-Assisted Special Education for Students with Exceptional Needs*. IGI Global, 2023.
- Lawrence, Japhet E, and Usman A Tar. "Factors That Influence Teachers' Adoption and Integration of ICT in Teaching/Learning Process." *Educational Media International* 55, no. 1 (2018): 79–105.
- Leedy, Paul D., and Jeanne Ellis. Ormrod. *Practical Research : Planning and Design*. Pearson, 2016.
- Maass, Katja, Vince Geiger, Marta Romero Ariza, and Merrilyn Goos. "The Role of Mathematics in Interdisciplinary STEM Education." *Zdm* 51, no. 6 (2019): 869–84.
- Marbán, José M, and Eddie M Mulenga. "Pre-Service Primary Teachers' Teaching Styles and Attitudes towards the Use of Technology in Mathematics Classrooms." *International Electronic Journal of Mathematics Education* 14, no. 2 (2019): 253–63.
- Mavellas, Sibanda, Mapenduka Wellington, and Furusa Samuel. "Assessment of the Availability and Utilization of ICTs for Teaching and Learning in Secondary Schools-Case of a High School in Kwekwe, Zimbabwe." *International Journal of Scientific & Technology Research* 4, no. 8 (2015): 282–88.
- Mishra, Punya, and Matthew J Koehler. "Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge." *Teachers College Record* 108, no. 6 (2006): 1017–54.
- Murithi, Julius, and Jin Eun Yoo. "Teachers' Use of ICT in Implementing the Competency-Based Curriculum in Kenyan Public Primary Schools." *Innovation and Education* 3, no. 1 (2021): 1–11.
- Mwaniki, F M, F K Nyamu, and M M Waititu. "An Exploration of the Integration of Ict in Mathematics Lessons in Secondary Schools, Garissa County, Kenya." *Journal of Education* 4, no. 1 (2024): 12–22.
- Ndlovu, Mdutshekelwa, Viren Ramdhany, Erica D. Spangenberg, and Rajendran Govender. "Preservice Teachers' Beliefs and Intentions about Integrating Mathematics Teaching and Learning ICTs in Their Classrooms." *ZDM* 52, no. 7 (December 24, 2020): 1365–80. <https://doi.org/10.1007/s11858-020-01186-2>.
- Ojo, OA, and EO Adu. "The Effectiveness of Information and Communication Technologies (ICTs) in Teaching and Learning in High Schools in Eastern Cape Province." *South African Journal of Education* 38, no. Supplement 2 (December 31, 2018): 1–11. <https://doi.org/10.15700/saje.v38ns2a1483>.
- Perienen, Appavoo. "Frameworks for ICT Integration in Mathematics Education-A Teacher's Perspective." *Eurasia Journal of Mathematics, Science and Technology Education* 16, no. 6 (2020): em1845.
- Phiri, William. "Pupils' and Teachers' Perception toward the Use of Information and Communication Technology (ICT) in the Teaching and Learning of Mathematics in Selected Secondary Schools of Central Province, Zambia." *International Journal of Multidisciplinary Research and Development* 3, no. 1 (2016): 77–87.
- Rana, Kesh, and Karna Rana. "ICT Integration in Teaching and Learning Activities in Higher Education: A Case Study of Nepal's Teacher Education." *Malaysian Online Journal of Educational Technology* 8, no. 1 (2020): 36–47.
- Tamunoiyowuna, Shedrack. "Availability and Use of ICT Materials in Teaching and Learning of

Physics among Senior Secondary Students in Obio-Akpor Local Government Area of Rivers State, Nigeria,” 2022.

Tariq, M. “10 Uses of Computers in Education.” *Educate Computer*, 2024.

Viberg, Olga, Åke Grönlund, and Annika Andersson. “Integrating Digital Technology in Mathematics Education: A Swedish Case Study.” *Interactive Learning Environments* 31, no. 1 (2023): 232–43.

Wu, Jinsong, Song Guo, Huawei Huang, William Liu, and Yong Xiang. “Information and Communications Technologies for Sustainable Development Goals: State-of-the-Art, Needs and Perspectives.” *IEEE Communications Surveys & Tutorials* 20, no. 3 (2018): 2389–2406.

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