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An Investigation into the Impact of Technology Use on the Teaching and Learning of Mathematics in Secondary Schools: A Case Study of Mwansabombwe District, Zambia

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Abstract. The study investigates the impact of technology integration use on Mathematics education in eight (8) secondary schools in Mwansabombwe District of Luapula Province, Zambia. The schools involved include Kabalenge Secondary School, Mabel Shaw Secondary School, Mukamba Secondary School, Kazembe Secondary School, Kapale Secondary School, Mumbolo Secondary School, Salanga Secondary School and Chinyanta Secondary School. The research aims to examine the effects of technology on student learning outcomes, engagement and motivation in mathematics as well as to explore teacher's perceptions and the challenges they face in implementing technology – enhanced instructions. Adopting a mixed – methods approach, the study combines quantitative and qualitative data collection and analysis. Surveys conducted among Mathematics teachers and students provide insights into current technology usage, perceived benefits and associated challenges. In addition, case studies of selected schools offer an in- depth understanding of technology integration practices and their influence on student learning. The goal of the research is to inform educators, teacher trainers and policy makers helping them optimize opportunities for improved mathematics instructions. Data collection included twenty recorded questionnaires at the school level, analysed using qualitative method.

Index Terms- activities, technology, mathematics, approaches, effects, learning, integration, strategies, teaching, secondary schools, Zambia.

I. Introduction

The integration of Information and Communication Technologies (ICT) in education has transformed teaching and learning processes globally. In Zambia the Ministry of Education has emphasized the incorporation of technology to enhance educational outcomes. However, the effectiveness of ICT in teaching mathematics, particularly in rural districts like Mwansabombwe, remains under – explored.

ICT have had an impact on the Zambian society and have changed the way people live, learn, work and play. Zambia has initiated the integration of ICTs in many sectors of national development. For instance, the Exanimation Council of Zambia (ECZ) introduced online Results collection system which makes it easier to collect results at every grade level. Another example is where most banks in Zambia now have e-banking, mobile banking and internet banking facilities. Furthermore, Open and Distance Learning (ODL) through e-learning has relatively grown in many Zambian education institutions. This revolution demands for basic ICT knowledge for

some careers in order for one to be competitively functional in the Zambian society today. However, this project endeavors to research on the application of ICTs in relationship with the teaching and learning of mathematics in selected secondary schools in Mwansabombwe District. Hattie (2009) defines ICTs as those technologies that can be used to interlink information technology devices such as personal computers with communication technologies such as telephones and their telecommunication networks. The PC and laptop with e-mail and Internet provides the best example. Michiels and Van Crowder (2001:5) defined ICTs „„ as a range of electronic technologies which when converged in new on figurations are flexible, adaptable, enabling and capable of transforming organizations and redefining social relations. "" Isaacs (2007) reviewed that the penetration levels of ICTs in Zambia's education institutions remain low, with those schools that are equipped mostly utilizing second-hand and refurbished computers. The integration of ICTs in teaching and learning practice has been limited, although the introduction of computer studies in school study subject has begun to change this. The adoption of a national ICT policy, as well as the development of a draft ICT policy for education and an associated implementation framework, provides an enabling policy environment to promote far greater access and use of ICTs across all sectors of Zambia 's education system. These include a system for enhancing education management, administration, teaching and learning. While the goals and targets set in the policy documents seem realistic. Besides, realizing them within the established time frames remains a challenge (Chibomba, Koopman and Stanton, 2009). The future of Zambia will be dependent on the size and quality of its human capital. Therefore, it is the duty of our education system to equip learners with relevant ICT knowledge and skills at all levels. "Gone are the days when Information Communication Technology (ICTs) was a luxury. The current times have called for an integration of education with ICTs which are creating new learning and teaching possibilities." (Sichone, 2011:9). "" MOTC (2006) reviewed that for developing countries like Zambia to make major progress in social and economic development, there is need to invest significant effort and resources in the education system

II. Literature Review/ Survey

The effect of integrating technology on teaching and learning of mathematics education is a subject of significant debate and research. While some studies have shown that technology can improve student's performance in mathematics education, other has found no significant difference. One study found that technology-based learning intervention, such as gasification and interactive software, resulted in improved mathematics performance for students' (Hillmayr et al., 2020). Additionally, technology can provide students with immediate feedback on their work, allowing them to self-corrected and adjust more quickly. However, technology is not a panacea for improving mathematics performance (Gómez-García et al., 2020). In some cases, technology can create new challenges for students, such as technical difficulties, distractions, or insufficient training in the use of the technology. Additionally, technology-based interventions may not be suitable for all students and may need to be tailored to individual learning styles and abilities. Furthermore, the effectiveness of technology-based interventions may depend on how the technology is used (Birgin & Acar, 2020). For example, using technology to supplement traditional

classroom instruction may be more effective than using it as a replacement for face-to-face instruction (Zengin, 2018). Overall, while technology has the potential to improve students' mathematics performance, the effectiveness of technology-based interventions depends on several factors, including the quality of the technology, the pedagogical approach used, and the individual needs and abilities on the students. Thus, it was suggested that: The performance of students in mathematics is directly boosted by the use of technology in mathematics teaching and learning. Technology & Student's Interest in Mathematics Research suggests that the use of technology in teaching and learning mathematics can have a positive effect on student's mathematics interest (Kelley et al., 2020).

Summary of key Findings

This chapter presents a comprehensive discussion of the findings, implications, and conclusions of the study on the effects of using technology in teaching and learning mathematics in Zambian Secondary Schools in Mwansabombwe district. The chapter synthesizes the key findings, interprets the results in the context of existing literature, and explores the implications for education practice and policy. The chapter also provides recommendations for stakeholders, acknowledges the study's limitations, and suggests directions for future research. By drawing together the threads of the study, this chapter aims to contribute to a deeper understanding of the role of technology in enhancing mathematics education in Zambia.

III. Discussion of Findings

The findings of this study reveal that the integration of technology in teaching and learning mathematics in Zambian Secondary Schools in Mwansabombwe district had a positive impact on student learning outcomes and teacher perceptions. The discussion below synthesizes the key findings in relation to the research questions and existing literature.

Improved Student Learning Outcomes

The study found that students who used technology to learn mathematics showed significant improvement in their test scores, engagement, and motivation. These findings are consistent with existing research that suggests technology integration can enhance student learning outcomes in mathematics (Kulik, 1994; Li & Ma, 2010). The interactive nature of technology-based learning environments likely contributed to the observed improvements.

Enhanced Teacher Perceptions

Teachers in the study reported positive perceptions of technology integration, citing benefits such as improved student engagement and enhanced teaching experiences. These findings align with existing research that suggests teachers' attitudes towards technology integration are crucial in determining its effectiveness (Ertmer & Ottenbreit - Leftwich, 2010).

The positive perceptions of teachers in this study suggest that they are likely to continue using technology in their teaching practices.

Challenges and Limitations

Despite the positive findings, the study also identified challenges and limitations associated with technology integration, including limited access to technology and technical issues. These challenges are consistent with existing research that highlights the importance of infrastructure and support in ensuring effective technology integration (Kenge & Anyanwu, 2013). The findings suggest that addressing these challenges is crucial to sustaining technology integration efforts. The discussion of findings highlights the potential benefits and challenges of technology integration in teaching and learning mathematics in Zambian Secondary Schools.

IV. Methodology

1. Research design

The research has both designs. It has qualitative and quantitative approaches.

2. Significance of the Study

The findings of this study may be useful to several stakeholders such as practicing mathematics teachers in schools, teacher educators, curriculum developers, the examining bodies and policy makers.

Firstly, the study was important as the results would enhance the teaching and learning of mathematics, which would subsequently contribute to the improvement in academic performance in Mwansabombwe district. It was one or among the first studies to be done in Mwansabombwe focusing on the teaching and learning of mathematics. Hence the findings of this study would provide insight into the challenges mathematics teachers face in the teaching and learning process. Apart from knowing the challenges mathematics teachers would master effective approaches of teaching and learning mathematics. Furthermore, the study was significant because it could help mathematics teachers understand different reasons why the teaching and learning approaches are underutilized. To add on, mathematics teachers may also find this work as an invaluable resource in finding solutions to the problems of teaching and learning of mathematics in secondary schools of Mwansabombwe district.

Secondly, it is hoped that the information obtained from this study may help teacher educators in Universities and Teacher Training Colleges to frame the syllabus for mathematics properly so that it can mitigate the poor performance in mathematics. In addition, the results from the study may also help universities and teacher training colleges to evaluate the content and pedagogical approaches used to teach student teachers of mathematics.

Thirdly, the findings from this study may help stakeholders in the Ministry of education for interventions and programmes to be put in place to improve performance in mathematics at senior level. The findings may be used by the Teacher Education Department (TED) and the Curriculum Development Centre (CDC). Teacher Education Department may use the document to scout for qualified manpower whilst the Curriculum Development Centre may use it to either necessity the change in the syllabus or to provide new teaching and learning materials in secondary schools.

Fourthly, the examining body which happens to be the Examination Council of Zambia (ECZ) is an authorized board which is responsible for preparing, conducting and certification of public examination in Zambia. Thus, MoE (1977) postulates that "By having public examination it is possible to maintain quality and uniformity as all candidates for a particular Programme are subjected to same measurement". Hence, the finding from the study was important in that it may help ECZ to re-focus and re-direct its mandate so that the pupils pass percentage in mathematics may rise.

Finally, the study was significant as it may help educational planners and policy makers to know the factors that are critical to effective planning in the education sector. This may not only assist policy makers market mathematics to the general public but may guide educational planners with authentic evidence on the problems that affect the teaching and learning of mathematics. Not only will the study contribute to the already existing body of knowledge but also to the existing mathematics literature on the teaching and learning of mathematics in Zambia. Hence or otherwise the study might also provoke further research and reflections on the mathematics teaching and learning. Furthermore, the researcher intends to do a presentation of his research findings in Mwansabombwe District to be sponsored by any non – Governmental Organization. Foundation where all stakeholders of education will be invited to attend. The researcher believes that after the presentation the teaching and learning of mathematics in Mwansabombwe may improve.

Piaget's Theory

In this research Piaget's theory was used to understand, collect and interpret data Piaget (1896-1980) was a genetic epistemologist who was the first to introduce the concept of levels of teaching and learning. Bruner (1960:34) suggests that, "The work of Piaget and others suggest that, roughly speaking, one may distinguish three stages in the intellectual development of the child". Apart from Bruner (1960) in agreement with the already stated statement Myers (2004) postulates that Piaget proposed that children progress through four stages of cognitive development, each with distinctive characteristics that permit specific kinds of thinking.

Ethical Considerations

Ethical considerations were carefully observed throughout the study. Informed consent was obtained from all participants, including both teachers and students, prior to data collection. Participants were assured of their anonymity and confidentiality, with personal identifiers removed from all data collected. They were also informed of their right to withdraw from the study at any time without any consequences. Ethical approval for the study was obtained from the relevant authorities at DMI St. Eugene University, Mansa Campus.

Results

The results for this dissertation presents the findings on the effects of technology on teacher and student perceptions of technology integration in teaching and learning mathematics in Zambian Secondary Schools in Mwansabombwe district. The study reveals that both teachers and students have positive perceptions of technology integration, citing benefits such as improved engagement, motivation, and

learning outcomes. However, teachers and students also acknowledged the challenges associated with technology integration, including limited access and technical issues. The study's findings suggest that technology integration can be a valuable tool for enhancing teaching and learning mathematics in Zambian Secondary Schools, but it requires careful planning, implementation, and support to overcome the challenges.

Research Questions

- What Is The Current State Of Technology Integration In Mathematics Education In Mwansabombwe District Secondary Schools?
- How Does Technology Use Affects Students Learning Outcomes In Mathematics,
- What Perceptions And Experience Do Teachers Have On Technology Integration In Mathematics Education?
- What Challenges Do Teachers And Students Face In Using Technology For Mathematics Education?

Hypothesis of the Research

The integration of technology in teaching and learning mathematics in Zambian Secondary Schools in Mwansabombwe district has a positive impact on student engagement, motivation, and understanding of mathematical concepts, but its effectiveness is hindered by challenges such as limited access to technology, internet connectivity issues, and lack of technical support. Teachers and learners view technology as a valuable tool for enhancing instructions. Technology integration was seen as a way to improve learners understanding and achievement in mathematics.
The study provides evidence that technology integration can increase student engagement and motivation, improve understanding of mathematical concepts, and enhance teacher-student interaction. However, the study also highlights the need for policymakers and educators to invest in technology infrastructure, provide on-going teacher training and support, and address the digital divide to ensure that all students have equal access to the benefits of technology-enhanced mathematics education.

V. Conclusion

In conclusion, this study demonstrates the potential benefits of technology integration in mathematics education in Zambian Secondary Schools. By addressing the challenges associated with technology integration and investing in teacher training and support, policymakers and educators can harness the power of technology to improve learner’s outcomes and enhance the quality of mathematics education in Zambia.

Limitation

The Limitation of this investigation is to explore the effects of using technology in teaching and learning mathematics in Zambian Secondary Schools specifically in Mwansabombwe District of Luapula province. This study focuses on the following limitations:

- **Geographical Scope:** The study is limited to secondary schools in Mwansabombwe district of Luapula province, which may not representative of the entire country

- **Sample Size:** The sample size may be limited due to resource constraints, which may affect the generalizability of the findings.
- **Technology Access and Availability:** The study's findings may be influenced by the availability and accessibility of technology in the selected schools.
- **Teacher and Student Willingness:** The study's success may depend on the willingness of teachers and students to participate and share their experiences with technology integration.
- **Contextual Factors:** The study's findings may be influenced by contextual factors, such as school infrastructure, resources and support, which may vary across schools. By acknowledging these limitations, the study's aims to provide enhanced understanding of the effects of technology integration in mathematics education in the specific context of Zambian Secondary School in Mwansabombwe district.

Theoretical Frameworks

Theoretical Frameworks for Technology Integration in Mathematics Education

- The integration of technology in mathematics education has been a topic of interest for researchers and educators globally. This literature review aims to provide an overview of the existing research on the effects of using technology in teaching and learning mathematics, with a focus on the Zambian context.
- **Technological Pedagogical Content Knowledge (TPACK):** This framework emphasizes the importance of teachers' knowledge of technology, pedagogy and content in effective technology Integration (Koehler & Mishra, 2009). Constructivist Theory:
- This theory suggests that learners construct their own knowledge and understanding through active engagement with technology. (Piaget, 1954).
- Empirical Studies Improved Student Outcomes Studies have shown that technology integration can improve student learning outcomes in mathematics, particularly in areas such as problem-solving and critical thinking (Rakes et al., 2010).
- **Increased Engagement:** Technology integration has been found to increase student engagement and motivation in mathematics, particularly among students who struggle with traditional teaching methods (BECTA, 2008).
- **Teacher Professional Development:** Effective technology integration requires ongoing teacher professional development, including training on technology use and pedagogical strategies (Lawless & Pellegrino, 2007).
- **Challenges and Barriers Access and Equity:** Limited access to technology and internet connectivity can create barriers to effective technology integration, particularly in rural or disadvantaged areas (UNESCO, 2018).
- **Teacher Resistance:** Some teachers may resist technology integration due to lack of confidence, training, or support (Ertmer, 2005).
- **Technical Issues:** Technical issues, such as hardware or software problems, can hinder effective technology integration (Keengwe & Anyanwu, 2013).
- **Zambian Context National ICT Policy:** Zambia's National ICT Policy aims to promote the use of technology in education, including mathematics education (MoE, 2014).

Challenges in Zambian Schools: Zambian schools face challenges such as limited infrastructure, lack of resources, and inadequate teacher training, which can hinder effective technology integration (Chibwili, 2018).

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