UNIVERSITY OF KWAZULU-NATAL ™

INYUVESI YAKWAZULU-NATALI

The Use of a Blog to Improve Mathematics and Mathematical Literacy Results of Grade 9 To 11 Learners at Thornwood Secondary School, Pinetown District

By

Mthobisi Ngidi

204512049

A dissertation submitted in fulfillment of the requirements for Master of Information Studies

Information Studies Department - School of Social Sciences

College of Humanities

University of KwaZulu-Natal, Pietermaritzburg, South Africa

2024

Supervisor: Dr Siyanda E Kheswa

DECLARATION

I, Mthobisi Ngidi, declare that

1. The research reported in this dissertation, except where otherwise indicated, is my original work.

2. This dissertation has not been submitted for any degree or at any other university.

3. This dissertation does not contain other persons' data, pictures, graphs, or other information unless specifically acknowledged as being sourced from other persons.

4. This dissertation does not contain other persons' writing unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:

4.1 Their words have been re-written but the general information attributed to them has been referenced.

Where their exact words have been used, their writing has been placed inside quotation marks, and referenced.

5. This dissertation does not contain text, graphics, or tables copied and pasted from the internet, unless specifically acknowledged, and the source is detailed in the dissertation and the references.

Mthobisi Ngidi

Signature:… 

Date:…03/02/2025……

Dr. S.E. Kheswa

Signature:… 

Date:…05/02/2025…….

DEDICATION

This dissertation is dedicated to my daughters Noluthando and Enhle. Because of your existence, I remain motivated and inspired to keep going.

ACKNOWLEDGEMENTS

This beautiful journey was recommended by Mrs Eslina J. Kheswa, her prayers from the beginning till the end are highly appreciated. Unfortunately, I lost my beloved mother, Thembekile B. Ngidi, along the journey, who told me to keep going and never stop, may her soul rest in peace.

However, with words of wisdom and support from a friend, a brother, and a supervisor like Dr. Siyanda E. Kheswa, I managed to keep going till the end. I appreciate you.

As Dr Kheswa would normally say, “Research is a very lonely journey,” but with friends, whom I now call brothers, like Sphamandla Ncane and Sphamandla Makaula, I was never alone. They believed in me more than I believed in myself. I appreciate you for showing me true brotherhood.

My brother Lucky Ngidi, for keeping the family together, which allowed me to focus on this journey, I appreciate you.

The Thornwood Secondary School learners and parents for allowing their children to participate in this journey, and the school management team for allowing me access to the school resources. I appreciate you.

Lastly, I thank the University of KwaZulu-Natal Pietermaritzburg, and Edgewood campuses for allowing me an opportunity to be a part of something this beautiful. I am grateful.

ABSTRACT

The challenge of mathematics remains a stumbling block for many learners in South Africa and many other countries. With the alarming number of learners who complete high school without mathematics, the subject of mathematical literacy (ML) was introduced in the South African curriculum. However, evidence that the problem still exists is found in the literature and is observable by those in the fields of mathematics and ML. As an educator, I needed to conduct an action research study under the critical paradigm that underpins the connectivist theory to address the challenge. This study aims to explore the use of a blog to improve mathematics and ML results of grade 9 to grade 11 learners and to explore the learners' perceptions and experiences towards using the blog. This study was conducted at Thornwood Secondary School, Marianhill area, under the Pinetown district. Since the study was dealing with minors, the issue of consent was addressed and followed according to the university regulations. The study purposively collected qualitative data, and conveniently collected quantitative data guided by a mixed-method evaluation design. Two closed-ended questionnaires, focus group interviews, and data comparison using secondary and primary data were the tools selected for data collection. The response rate was 100% due to everyday access to the participants, and all of them agreed to participate in the study. The findings revealed that most learners had positive perceptions of using the blog before training on the blog. They believed that the blog would be a good medium of teaching and learning, and it would be beneficial for them to use the blog in learning mathematics and ML The learners gained various skills, including collaborative learning, organising learning material on their blogs, and sharing links of information with other learners. There were also some challenges that learners experienced while using the blog: technical issues, real-time access, and internet availability and affordability. Nonetheless, learners managed to improvise, adapt, and overcome these challenges, which is considered part of learning. There was an increase in the average marks for learners using the blog. Statistical tests, backed up by the literature, revealed that the increase was influenced by using the blog. The study concluded that using the blog can help improve learners' results through increased learner interest in a subject, decentralised access to information, and collaborative learning. Learning with the use of technology is the future of learning. It is recommended that more attention should be given to making ICT and the Internet available at schools, specifically, public schools.

LIST OF ABBREVIATIONS AND ACRONYMS

BLOG	Weblog
FET	Further Education and Training
ICT	Information and Communication Technologies
ML	Mathematical Literacy
NCS	National Curriculum Statement
SASAMS	South African School Administration and Management System
SPSS	Statistical Package for Social Science
Wi-Fi	Wireless Fidelity

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. CHAPTER 1: INTRODUCTION TO THE STUDY

1.1 Introduction

This chapter provides an overview of the entire dissertation. It starts by unpacking the study's background and outlining a research problem. It then discusses preliminary literature and the reason for choosing the study. The research objectives, followed by the key research questions, are introduced. The theoretical framework that underpins this study is outlined in this chapter. Furthermore, the research design and methodology including the paradigm, approach, population and sampling, data collection process, validity and reliability, data analysis, ethical considerations, and limitations and delimitations of the study are outlined in this study. The definition of key terms is done in this chapter, and finally, the structure of the dissertation is outlined to conclude the chapter.

1.2 Background to the study and outline of a research problem

Thornwood Secondary School is situated at Thornwood in the Pinetown district, near Marainhill. This school teaches grades eight to twelve. From grade ten, learners are divided into three learning streams: commerce, science, and general. As a mathematics and Mathematical Literacy educator at Thornwood Secondary School for 9 years, the researcher observed that learners are performing poorly in these learning areas. Unfortunately, this is a national challenge that the Department of Education has been experiencing. Poor mathematics and other science achievements have been a major problem confronting the South African basic education system (Chimuka, 2017). To address this problem, many changes in the South African curriculum have been made, which led to the introduction of mathematical literacy. The introduction of mathematical literacy in the FET band was met with mixed feelings by both learners and teachers. For the learners, if they were doing mathematical literacy, they were categorised as retarded or slow because it was viewed as a generic type of mathematics for weak learners (Mshengu, 2019). Mshengu (2019) explains that for teachers, the subject brought anxiety when they realised that not all teachers can teach mathematical literacy and that it requires a strong mathematics background. Note that mathematical literacy refers to competence or skill, while mathematical literacy (ML) refers to the school subject. The competencies developed through ML allow individuals to make sense of, participate in, and contribute to the twenty-first-century world. Such competencies include the

ability to reason, make decisions, solve problems, manage resources, interpret information, schedule events, and use and apply technology (DBE, 2011). For research purposes and the need to collect as much data as possible, the researcher chose Thornwood Secondary, where he teaches, and excluded grade 8 learners because of being new in the school and grade 12s as the busiest grade in school. Therefore, this research will explore whether the use of a blog can improve mathematics and ML for grade 9 to grade 11 learners. This research will also explore learners' perceptions of using the blog and their experiences of using the blog. A blog is a website that contains dated entries called blog posts in reverse chronological order. In the education field, it is often believed that learners' interest in the subject influences their performance. Acharya (2017) testifies that students' achievement depends on their needs, interests, and seriousness in the subject matter. As a result, understanding the perceptions and experiences of the learners about this learning method becomes crucial in this study.

1.3 Problem statement

Many students struggle with mathematics ML due to a lack of support and motivation, limited access to resources, and ineffective traditional teaching methods. Low performance in mathematics and ML is often linked to difficulty grasping abstract concepts, minimal opportunities for real-world application, and a lack of continuous learning outside the classroom. Learning through the blog offers an interactive, accessible, and self-paced approach that enables students to engage with mathematical concepts more meaningfully. Through explanations, real-world examples, interactive discussions, and peer collaboration, blogs can provide a dynamic learning experience that enhances comprehension and problem-solving skills. Nonetheless, the effectiveness of blog-based learning in improving students' mathematics and ML performance remains largely underexplored. This study aims to examine whether the use of blogs can be used to improve the mathematics and ML results of Thornwood learners. The researcher will also come to an understanding of the perceptions and experiences of learners who are using the blog for further improvement.

1.4 Preliminary literature and reason for choosing the topic

The South African curriculum, particularly the secondary school mathematics curriculum, has undergone extensive transformations since 1994. These transformations have inevitably brought several pedagogical and instructional challenges (Chimuka, 2017). Several factors are associated with the poor performance of learners in mathematics, and they result from both teachers' and learners' shortcomings. Student-related factors include mathematics anxiety, prior knowledge of students, and students' labour in learning mathematics (Archaya, 2017). According to Zulu (2020), mathematics teachers are not sufficiently trained to integrate technology in secondary schools for teaching and learning. The main reasons why teachers do not use technology are typically associated with their knowledge and beliefs. Having tried all the possible solutions to combat poor performance in mathematics, in 2006, the Department of Education introduced Mathematical Literacy as an option for learners who did not perform well in mathematics. The reason for introducing this subject was because of an increased number of learners who exited grade 12 without mathematics, and it was introduced to ensure that every learner who exits grade 12 possesses mathematical knowledge and skills (Dlamini, 2016). The subject of Mathematical Literacy should enable a learner to become a self-managing person, a contributing worker, and a participating citizen in a developing democracy. Furthermore, teaching and learning mathematical literacy should thus provide opportunities to analyse problems and devise ways to work mathematically in solving such problems (DBE, 2011). The experience would also present them with the opportunity to connect with the real-life problems that are encountered in different situations (Dlamini, 2016). The challenge was that the newly introduced subject, ML, was taught by teachers who specialised in other subjects (Mkhize, 2019). According to Mshengu (2019), since this was a new subject, teachers of ML were encouraged to work collaboratively as clusters to be able to face the challenges of teaching this new subject and to review their classroom practice as Mathematical Literacy teachers collectively. Teaching methodology is a common factor in poor performance in mathematics and mathematics literacy.

Consequently, due to underperformance in mathematics, innovative methods have been considered and introduced into mathematics classrooms (Mlilo, 2019). Hansraj (2021) discovered that using YouTube videos, PowerPoint presentations, and worksheets to teach the topic of shape and space in grade 10 mathematical literacy helped to improve learner understanding. Therefore, it seems

that the purpose of integrating technology in teaching is to enhance the lessons, thereby making the concepts that are not easy for learners to grasp more comprehensible (Zulu, 2020). Using internet-based learning media, such as a blog, has been proven to increase learners' interest in mathematics. Simangunsong and Irvan (2023) define weblogs or blogs as text documents, images, media objects, and data that are arranged hierarchically and according to a certain chronology that can be viewed via an internet browser (e.g., Internet Explorer). Teachers can utilise blogs to increase the communication among participants of the course as well as the level of their participation and the depth of engagement. Furthermore, according to Siregar, Frisnoiry, and Andreani (2020), students find learning with a blog more motivating, and submitting is more fun. Learning without a blog was considered monotonous and did not attract students, which led to less motivation, decreased communication, and poor performance. Ismail, Firtainai, Takdir, Sudirman, and Umar (2019) argue that blog-based mathematics learning can be an alternative to understanding mathematical material that is more open, flexible, and less boring. As a mathematical literacy and mathematics teacher at Thornwood Secondary School, the researcher has noticed the passion learners have for social media and the internet. This led him to a solution of integrating the blog with learning mathematics and mathematical literacy to create more interest in the subjects. My decision is backed by literature from international and national researchers who have found that using blogs is effective for learning mathematics and mathematical literacy. Therefore, this paper will explore the use of the blog as a method to improve the results of mathematics and mathematical literacy for learners and to explore the learners' perceptions and experiences toward using the blog.

1.5 Research objectives and key questions

This section outlines the research objectives and key research questions.

1.5.1 Research objectives

The objectives that this research seeks to achieve are:

1.5.1.1 To explore if the use of the blog can improve the results of grade 9 to 11 for mathematics and mathematical literacy (ML)

1.5.1.2 To explore the learners' perceptions towards using the blog.

1.5.1.3 To explore the learners' experiences of using the blog

1.5.2 Key research questions

1.5.2.1 What are learners' perceptions and experiences towards using the blog?

1.5.2.2 What are the key challenges of using the blog?

1.5.2.3 Can the use of a blog in learning mathematics and ML help improve the learners' results?

1.6 Principal theories (Research design)

This research will be guided by the connectivism theory. This is a digital age theory founded by George Siemens and Stephen Downes in 2005-denouncing boundaries of behaviorism, cognitivism, and constructivism (Duke, Harper, Johnston, 2013). According to Downes (2022), Connectivism is the thesis that knowledge is constituted of the sets of connections between entities, such that a change in one entity may result in a change in the other entity, and that learning is the growth, development, modification or strengthening of those connections. Siemens (2004) argues that behaviorism, cognitivism, and constructivism theories were developed before learning was impacted by technology. Connectivism theory holds that learning can happen through social networks. One of the significant trends of learning that Siemens (2004) noted was that informal learning is a significant aspect of the learning experience. Formal education no longer comprises the majority of our learning. Learning now occurs in a variety of ways through networks and through the completion of work-related tasks. In mathematics, complex calculations can be demonstrated through video or audio to accommodate different learning styles. A blog is also synchronous, meaning it allows interactive communication. This enables learners and the instructor to network with each other in real-time for further clarification. Figure 1.1 below presents the illustration of the model:

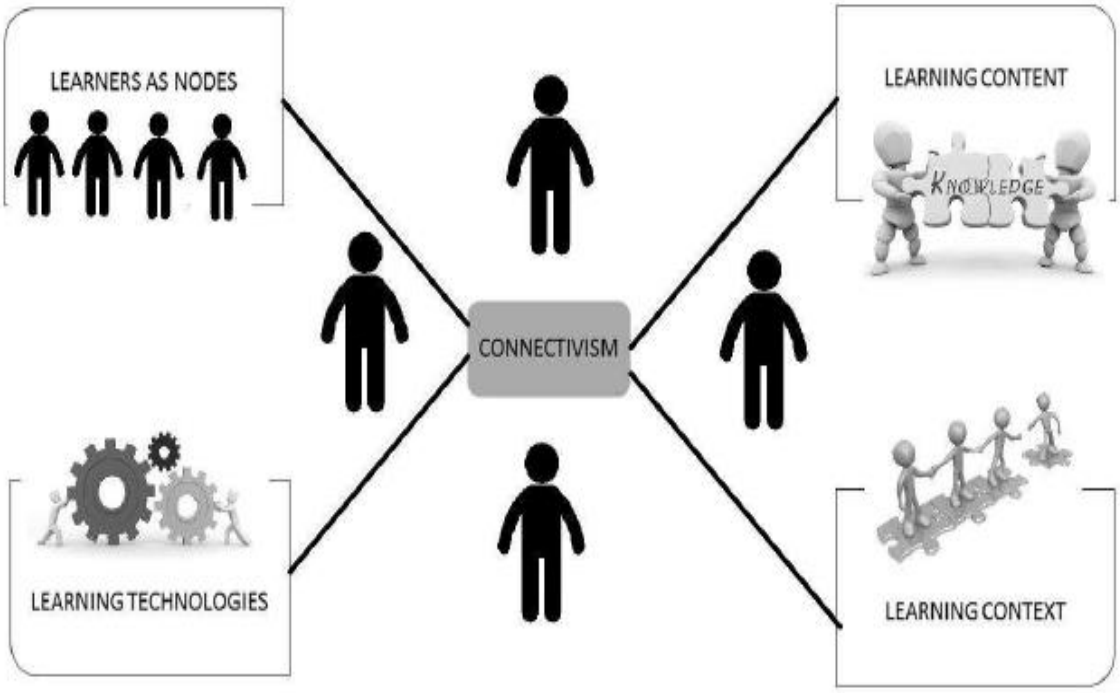


Figure 1.1 Connectivism framework (Chetty, 2013)

Learners become nodes that form a learning network. They use learning technologies, such as literacy blogs, to exchange learning content as signals. In doing so, the change in the state of one node in the network can cause or result in a change in the state of other nodes in the network. This process facilitates development and growth through networking.

1.7 Research methodology and methods

This section discusses the research methodology used to conduct the proposed study.

1.7.1 Paradigm

The nature of this research is to critique and transform. As a result, the critical paradigm is used to guide the study. According to Bertram and Christiansen (2017), the focus of the critical paradigm is bringing about some kind of social change that will benefit those groups who are understood to

have little power, or fewer opportunities or choices open to them. Change can be brought about as the product of the research or through the process of research itself.

1.7.2 Research method/approach

The study uses a mixed-method approach (qualitative and quantitative approaches). This approach will follow a mixed-method evaluation design. This method will allow the researcher to integrate a mixed-methods design with action research.

1.7.3 Research design

The study will be in the form of action research by Ken Lewis (1946). This kind of research has multiple phases and is spiral in nature. Each phase contains cycles that involve planning, acting, observing, and reflecting. In education, action research can be defined as the process of studying a school situation to understand and improve the quality of the educational process. It provides practitioners with new knowledge and understanding about how to improve educational practices or resolve significant problems in classrooms and schools (Harerimina, 2017).

1.7.4 Population and sampling

For qualitative data collection, 20 mathematics learners were purposively selected in Grade 9. In Grade 10, 5 mathematics learners and 10 ML learners were purposively selected, summing up to 15 learners in total. Grade 11 followed the same logic, with 5 mathematics learners and 10 ML learners, purposively selected.

A total sample of 50 learners was conveniently selected for quantitative data collection. A comparison of primary and secondary data was conducted at two levels. The first level was a comparison of all learners' marks before the blog and after using the blog. The second level includes a comparison of a sample of 50 participants' marks before the blog and after using the blog. These learners were selected because they were easily accessible and were in the same school where the researcher teaches.

1.7.5 Data collection process

For qualitative data, open-ended questionnaires and focus groups were used to collect the data. Using this collection method in parallel eliminates the biases that may arise from a researcher when collecting data because the view of the findings comes from both the researcher and the participants. For quantitative data, the study uses closed-ended questionnaires to get overall data across all grades of interest. Secondary and primary data were also used as quantitative data.

1.7.6 Validity and Reliability

With Action research, validity comes from the fact that the researchers are observing and evaluating changes that they instigated (Bertram and Christiansen, 2014). The piloting method will be used to identify any problems before the questionnaire is distributed to the learners for reliability. Member checking will also be done for qualitative data.

1.7.7 Data analysis

This study uses descriptive statistics for quantitative data. Thematic analysis techniques were used to analyse qualitative data from open-ended questionnaires and focus groups. Moreover, the information was presented in the form of tables and graphs for a clear understanding and is further discussed in a designated chapter. The researcher compares results before and after the blog for all learners and for the learners who use the blog before and after using the blog. This will help the researcher to answer the key research questions and objectives of the research.

1.7.8 Ethical issues to be considered

This study considers the confidentiality, privacy, and consent of the participants. All the data collection tools and interaction with the participants commenced after signing the university's ethical clearance. Furthermore, participants were notified of the process and that their participation was optional. The study collected data from the minors, and a consent form was given to parents/guardians to sign before collecting data.

1.7.9 Limitations and delimitations of the study

This study focuses on grades nine to eleven mathematics and ML learners. Only learners with access or who have digital tools will be considered for the study.

1.8 Definition of key terms

***Blog*.** A blog is a regularly updated website that provides insight into a certain topic, typically run by an individual or small group and is written in an informal or conversational style (Weiner, 2022).

Digital tools can be defined as programs, websites, applications, and other internet and computerised resources that facilitate, enhance, and execute digital processes and overall digitisation efforts (Walkme, 2023)

1.9 Structure of dissertation

Chapter One: ***Introduction*.** This chapter will discuss the general problem area, research questions, and objectives. The importance of the research, research approach, limitations, and key assumptions will be discussed in this section.

Chapter Two: ***Literature review and theoretical framework.*** This chapter discusses prior research and provides the background and context of the study. Published and unpublished research will be reviewed in this chapter**.**

Chapter Three: ***Description of research methodology*.** This chapter will discuss the methodology and the methods that were used to collect data. The theory/theories that underpin this research will also be explained in this chapter.

Chapter Four: ***Research results.*** This chapter will deal with presenting the results using tables, graphs, and figures.

Chapter Five: ***Analysis of results.*** This chapter will discuss the conclusions drawn from the data and the implications of a theory.

Chapter Six: *Conclusion and Recommendations.* This chapter will summarise the research with emphasis on the results and their contribution, as well as recommendations, suggestions for further research.

1.10 Summary of the chapter

This chapter has introduced the research. It highlighted the aims and objectives of the study. In this chapter, the key questions for the research were outlined. This chapter gives definitions of the important terms that will be used throughout the research. The next chapter reviews the literature related to the topic.

2. CHAPTER 2: LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Literature review

2.1.1 Introduction

Mathematics results have posed a serious concern, which shows a challenge in teaching and learning this subject in most schools. The crisis that is being signalled by the results seems to be across the board in the Further Education and Training (FET) band, as well as in the General Education and Training (GET) band (Cele, 2015). In a South African high school curriculum, achievement in mathematics is a prerequisite to science and commerce study streams. Students who wish to graduate with a science or commerce certificate, diploma, or degree must have achieved a senior certificate with pure mathematics as an admission requirement. As a result, learners without mathematics do not have a chance to study science and commerce at tertiary institutions. Mathematics is a language that uses symbols and notations to describe numerical, geometric, and graphical relationships. It helps to develop mental processes that enhance logical and critical thinking, accuracy, and problem-solving, which will contribute to decision-making (Department of Education (DoE), 2011). Mathematics is graphical, numerical, and symbolic, making it unique from other subjects learned using text and alphabets. As much as Mathematical Literacy was presented as an alternative to mathematics, admission to study science and commerce degrees still requires pure mathematics. Mathematical Literacy has more word problems that require understanding the problem before providing a solution. In a classroom of learners who are not first-language speakers of the language of instruction, which is English, Mathematical Literacy can be challenging. The terminology can be very confusing to learners, leading to high failure of the subject. Note that mathematical literacy refers to competence or skill, while Mathematical Literacy (ML) refers to the school subject.

This chapter reviews scholarly studies on the challenges of mathematics and ML in high schools. In contrast, literature on teacher and learner problems in mathematics and ML will be reviewed. To investigate the effectiveness of technology in learning mathematics and ML, the study will consult relevant and supporting literature. Furthermore, scholarly studies that align with learning through the usage of blogs will be reviewed. The focus will be on the literature on the usability of a blog to learn mathematics and ML. To better understand the challenges of learning through technology, a literature review on the challenges of using technology in learning will be conducted.

2.1.2 Challenges of mathematics and mathematical literacy (ML)

In trying to understand the challenges in mathematics, the National Commission on Special Needs in Education and Training (NCSNET) and the National Committee on Education Support Services (NCESS) identified several barriers to effective teaching and learning of mathematics. The report identified the medium of instruction and communication, inappropriate and inadequate provision of support services, lack of access to basic services, attitude, and lack of human resource development as barriers to effective teaching and learning of the subject (Cele, 2015).

In a South African high school curriculum, the language of teaching mathematics is English. Mathematical Communication Skills (MCS) refer to the student's ability to (1) arrange and link their mathematical thinking through communication; (2) communicate their logical and clear mathematical thinking to their friends, teachers, and others; (3) analyse and assess mathematical thinking and strategies used by others; and (4) use mathematical language to express mathematical ideas correctly (Rohid and Rusmawati, 2019).

More research has discovered that the causes of mathematics problems cut across all stakeholders in education; in other words, causes of poor performance in mathematics among senior secondary school students emanate from schools, students, teachers, as well as the government itself (Sa'ad, Adamu, and Saqid, 2014).

2.1.2.1 School resources related challenges

Tachie and Chirese (2013), and Howie and Scherman (2008) as cited by Madela (2016) discovered evidence that black schools are struggling to make it out to the science field and this is informed by the lack of resources which the government is failing to provide whereas the school in the urban areas, previously known as model C schools have more capacity in increasing the performance standards in mathematics and science, hence they contribute vastly in the science field. Inappropriate and inadequate provision of support services for mathematics, therefore, leaves learners from disadvantaged backgrounds and schools with less to no support to enhance their learning experience of mathematics. Sa'ad et al (2014) add that causes like inadequate qualified

teachers, instructional materials, libraries, and laboratories, poor attitude of students, improper teaching methods, anxiety, home background, overcrowded classrooms, interrupted teaching, dyscalculia, poorly motivated teachers and so forth bring about poor performance in mathematics among senior secondary school students in Nigeria.

In 2012, the Department of Education published the guidelines relating to planning for public school infrastructure. The document identified adequate sanitation facilities that promote health and hygiene standards and comply with all relevant laws, basic water supply, electricity, and wired or wireless connectivity for communication as basic services for schools. Maphoso and Mahlo (2014) define basic facilities as those that facilitate the smooth running of the school and include infrastructure, buildings, water, electricity, and sanitation. An interruption in the supply of water or electricity can render a school not conducive for learning; learners have to be sent home. Furthermore, mathematics constantly builds upon itself. Because of the cumulative nature learning process involved in the subject, prior knowledge is of the utmost importance. Frequent absenteeism or transfer to a new school may result in a gap in students' knowledge. Furthermore, some schools still face the problem of overcrowded classes, which makes it difficult for an educator to control a class and cater to every learner's needs.

The shortage of resources to bring ML to real-life contexts for learners might miss a great potential to enhance student achievement. According to Bansilal (2016), the ML curriculum integrates topics related to financial literacy (e.g., inflation, taxation, tariff systems, interest calculations, and mortgage rate calculations), health literacy (e.g., HIV infections, TB infection rates, infant mortality rates, and health charts), probability literacy and other topics. The intention is not for learners to do more mathematics, but more application and to use mathematics to make sense of contexts which they encounter in their daily lives. As an educator, I have also observed that many learners abandon the science and commerce streams in grade 10 to avoid mathematics. As a result, the classes for ML are much bigger in numbers, with less space to perform some demonstrations for learners. High temperatures and chaos are amongst other problems associated with teaching a class with many learners, and this can disrupt the teaching of the lesson.

The consensus amongst South African studies is that the availability or scarcity of key school resources impacts educational outcomes, with higher levels of resources being linked to better

educational outcomes (Vissa et al, 2015). This implies that there is still an inequality gap in education, with private schools being well-known for being resourceful compared to public schools. As a result, they don't get individual attention from their teachers, and in some instances, they lack adequate textbooks and laboratory equipment. Graham (2023) identified a problem of overcrowded classrooms, stating that there is growing global concern concerning South African learners' mathematics achievement, with research identifying many factors contributing to poor mathematics achievement, with class size being one of them. With a limited school budget, it may seem impossible to allocate a textbook for each learner. The problem of learning resources can see teachers leaving the school for better-resourced schools, leaving learners with a problem of teacher shortage; as a result, learning time is lost while trying to find a new teacher. Vissa et al's (2015) findings on a study of school factors associated with performance in South African schools suggested that poorly resourced schools also have teachers with poor qualifications, while better-resourced schools can attract good quality teachers with higher qualifications. This problem of resources is also felt by ML students; hence its practice is more context-related. That means for an ML learner to develop an interest in a subject, it should be as close to his/her everyday life as possible. Resources for demonstration and teaching must, therefore, match the current environment and situations of learners.

2.1.2.2 Teacher-related challenges

Teacher knowledge is at the heart of quality education (Nguse, 2020), and teachers who are not well-developed in teaching mathematics can affect the level of understanding of mathematics. Teachers' curricular and theoretical knowledge may improve if there is an investment in the education of teachers who are within the school system (Safura, 2017). A key resource and agent in all schools, particularly in schools for the poor, is the teacher. In some studies, the effect of the apartheid era has been identified as one of the reasons for poor teacher content knowledge, mostly in public schools. Adler and Pillay (2017) state that in 1994, only 64% of all teachers in South Africa were considered qualified; they had a grade 12 and 3 years of appropriate post-school training. Many of these teachers obtained their qualifications under the apartheid post-school training. In that era, the training of black teachers, particularly in mathematics and science, was woefully inadequate (Adler and Pillay, 2017). As a result, inherited values and beliefs about the subject are carried forward from generation to generation of teachers. Teachers' beliefs can be

largely affected by their prior mathematics experiences and teachers, and their studies in undergraduate education (Genc and Erbas, 2019). Even though there is a small number of learners who pass Grade 12 with mathematics and science, not all of them choose a career in teaching. With the challenge of qualification and shortage of teachers in mind, pedagogical content knowledge is another problem mathematics teachers are faced with, because of the curriculum changes.

The South African Curriculum, in general, has gone through many changes, and the mathematics and science teachers' content knowledge has been affected. The multiple changes in the mathematics curriculum have harmed the content knowledge that teachers have. According to Adler and Pillay (2017), teachers in South Africa have been confronted with three curriculum changes in the country since 1994; each bringing increasing specifications of content to be taught, the pace at which this should be done in each grade, and concerning learning support materials. Teachers had to keep their methods of teaching updated to meet the new curriculum demands, and publishers needed to write new content for learner textbooks and teacher guides to keep up with the demand. With continuous mathematical changes, professional development would be a necessity for mathematics teachers to participate in adopting curriculum changes (Safura, 2017). Nguse (2020) adds that teaching and learning are two sides of the same coin. Since teachers cannot pass on the knowledge they do not have, initiatives to improve learner attainment in mathematics must be linked to initiatives to develop teacher knowledge. However, learning new methods was not well adapted by some teachers. A study by Brijal (2013) discovered that teachers were given lots of materials in the form of hand-outs and textbooks, which many teachers were unable to teach themselves since they were unable to ascertain exactly what strategies to use with all the knowledge that they were confronted with. On the other hand, there have been problems, as many have said, billions of rands have been poured into various upgrading and professional development programs by both the state and through private sector funding of non-governmental organisations (Adler and Pillay, 2017). The problem with these interventions is that they do not reach all the teachers in the country because of the inequality gap. According to Chirinda, Kitchen, Castellón, and Matute (2023), Teachers at historically disadvantaged schools that taught black students during apartheid attend mandatory government-sponsored workshops and have the option of attending additional PD workshops offered by non-governmental organisations. However,

analyses from the 2011 TIMSS assessment demonstrate that black South African students in grade 9 achieved significantly lower levels on the assessment than their White 9th-grade South African counterparts (Chirinda et al., 2023). These results raise questions about the effectiveness of these developmental programs.

On the other hand, Mkhize (2019) explains that the challenge with the newly introduced subject, ML, is that it was taught by teachers who specialised in other subjects. Therefore, there was a need to retrain them. The Advanced Certificate in Education ML (ACEML) program was introduced as a formal professional development initiative to re-train such teachers. However, insufficient time was spent on the content and the pedagogic content knowledge. Hence, this training proved inadequate in terms of professional development (Mkhize, 2019). Brijal (2013) discovered that teachers were given lots of materials in the form of hand-outs and textbooks, which many teachers were unable to educate themselves with, since they were unable to ascertain exactly what strategies to use with all the knowledge that they were confronted with. Bansilal and Pillay (2019) conducted a study to explore the extent to which the approaches used by ML teachers supported the learners' participation in the contextual settings and found that the teachers' explanations of contextual terms were sometimes incorrect and irrelevant. By definition, ML is a context-based subject, therefore, it is ultimately teachers who are responsible for recontextualising the curriculum documents into classroom practices (Bansilal and Pillay, 2019).

Without a doubt, the important person in the curriculum implementation process is the teacher, and with the knowledge, experiences, and beliefs, teachers are central to any curriculum development effort (Dube, 2019). However, changing the curriculum frequently can be a challenging process for educators who will need to constantly update their knowledge to keep up with the changes. According to Safura (2017), with the numerous challenges that teachers have to face with curriculum change and teaching mathematics, there will be anxiety and feelings of negativity towards mathematics and the teaching of mathematics. Bhargava and Pathy (2014) add that changing times have added a new dimension to this profession, which requires specified competencies and the right attitude. The behaviour, attitude, and interest of the teacher help in shaping the personality of the student. Knowledge of teaching mathematics may affect the attitude of a teacher when delivering the lesson and addressing the questions from learners. Furthermore, the working conditions and their dynamics may affect the teacher's attitude toward teaching

mathematics. This can be influenced by, amongst other factors, the behaviour of the learners, the overcrowded classes, relations with other staff members, and even the remuneration itself. Mathematics teachers are often required to put more hours outside the normal school hours, including holidays, which they are not paid for.

ML teachers have their problems when it comes to facilitating the subject. The most common problem with this subject is being looked down on by both the learners and teachers. According to a study conducted by Botha, Maree, and Stols (2013), the idea that ML is inferior to other subjects in general, but to mathematics in particular, was alluded to by some participants, alongside the notion that it was infra dig to teach it. ML requires teaching that is unique from other science subjects, unfortunately in some schools, it is perceived as a subject that can be taught by any educator. Botha et al (2013) mention that since the subject was introduced as new in 2006 and was immediately taken by a large number of learners, many teachers were co-opted into teaching it, whether they had a mathematical background or not. As a result, some of these teachers do not have confidence in the subject and hardly give it the necessary attention. Genc and Erbas (2019) stress that teachers' conceptions play a significant role in forming their instructional behaviors and practices in the classrooms to reach the desired outcomes and meet the requirements of mathematics education in the context of mathematical literacy in a substantial way. This kind of teacher is unlikely to perform well in delivering the curriculum. Nonetheless, Goos and O'Sullivan (2023) stress that ML was designed to provide democratic access to *mathematics for all* rather than as a watered-down subject for mathematically weak students.

According to Goos and O'Sullivan (2013), the lack of school-based curriculum leadership in mathematical literacy, lack of teacher understanding of how to teach mathematics in real-life contexts, and disparities in access to resources between private schools and poorer public schools threaten to undermine the potential of the Mathematical Literacy subject to meet its transformational aims. As a mathematical literacy teacher, the researcher observed that during moderation workshops, where educators of all the schools within the district meet, learners from private schools perform better on average compared to learners from public schools. I also observed that the number of learners from both these schools differ significantly, with private schools having lower numbers. The researcher went as far as to question some of his colleagues about their teaching methods and techniques. They mentioned the use of technology as one of the

effective teaching methods. The class size and teaching resources play a huge role in how an educator delivers his/her lesson.

The Department of Education (2011) makes it clear that since the focus in ML is on making sense of real-life contexts and scenarios, in the ML classroom mathematical content should not be taught in the absence of context. A teacher with one textbook and no photocopy machine, teaching about a municipal utility bill in a crowded class is teaching with all hands tied up. Learners need to see the real municipal bill or a picture to identify it and work with it should it be required. The Department adds that in exploring and solving real-world problems, it is essential that the contexts learners are exposed to in this subject are authentic (i.e., are drawn from genuine and realistic situations) relevant, and relate to daily life, the workplace, and the wider social, political and global environments (DoE, 2011). It is evident that to teach ML properly, supporting resources must be available for educators. Gen and Erbas (2019) narrate that even though the concept of mathematical literacy has become a personal attribute very much dependent on the context in which the individual operates and might mean different things to different people including teachers, it lays particular stress on inclusion of learners about access important mathematics and improving students' capacity to make use of mathematics in different contexts.

Lastly, among many problems teachers face when teaching ML is the language of learning and teaching (LoLT) the subject. English is a key element that determines the understanding and performance of learners in numeracy (Nyandoro, 2019). Robertson and Graven (2019) view the dominance of a single language of power as the medium for education to have major implications for access to learning for those who do not speak this language at home and who are often already marginalized in terms of access to social and economic goods. Most teachers and their learners deal with presented contexts in their second or third languages, which can create contextual interpretation problems and obscured mathematical content. As a teacher, the researcher has encountered many situations where he had to use his home language to clarify some concepts to the learners. Learners also battle to answer the examination questions set by the Department. However, when revising the paper with the learners thoroughly, you can notice that if they had understood the question they would have arrived at the correct answer. Nyandoro (2019) identified some of the terms that appeared on a grade 12 national ML paper 2 of 2014 which he deemed rather challenging for learners who were not from an English background. The words included:

data, discrete, continuous, model, range, mean, quartile, random, probability, maximum, unbiased, outcomes, average, trend, gross, inflation, increase, income, and approximate. This is a clear indication that ML teachers need to extend their scope of teaching to involve teaching English, leading to a loss of time, and a shift from the core subject. According to Matope (2022), teachers of ML have the dual role of making sure the learners understand the language of instruction as well as understanding the mathematical languages as learners are still struggling with English as the LoTL.

2.1.2.3 Learner-related challenges

For the argument of this paper, it is also important to review the problems that learners themselves experience, and that contribute to the lack of performance in the subject of mathematics and ML. It is not a concealed fact that, for most learners, mathematics is perceived as hard, and almost no one's favorite. Those who pass it are considered to be smart and clever. For Reddy and Fadiji (2021) the belief in one's ability to succeed is related to achievement in learning domains and such belief is engendered through confidence in the capability to perform tasks (mastery experience), evaluating one's prospect of achieving a task by observing other learners' successful performance (vicarious experience), other individuals' evaluation of the learner's capability (social persuasion) and physical experiences when engaging in a specific task. Acharya (2017) described negative feelings towards mathematics learning as mathematics anxiety, and that it affects the student's learning process. Many factors outside the mathematics classroom can influence the attitude of learners. According to Sa'ad et al. (2014), the students bring to the instructional setting their abilities, motivational propensities, personal background; home background, and community values and these can mar, make, or supersede the teacher's intervention of whatever quality. These factors shape how a learner looks at the subject, and so is the learning and teaching of the subject.

Attitude is another contributing factor in the failure of mathematics in high schools. Attitude can be a set of beliefs or emotions associated with mathematics. Remu (1998), cited by Madela (2016), mentioned that the attitude that students have towards a subject affects the way they react and listen to the teacher. The learners' attitudes towards mathematics are shaped by several contextual influences. These influences include experiences in school but also the student's encounters with cultural norms, parental expectations, and societal images of mathematics and what it means to do

mathematics that are derived from outside of school (Martin, Towers, and Takeuchi, 2018). In addition, there is a general belief that a learner's attitude towards a subject determines their success in that specific subject. Veliappan and Muthulakshmi (2016) narrate why a favourable attitude results in good achievement. For Veliappan and Muthulakshmi (2016), a student's constant failure in a school subject and mathematics, in particular, can make him/her believe that he/she can never do well in a subject and thus accept defeat. On the other hand, his/her successful experience can make him/her develop a positive attitude towards the subject.

In a South African black home, there is likely to be a member of a family who went to school during the apartheid era when a black child was deprived of education in mathematics and science. Learners from such homes often battle to find assistance in their studies, particularly mathematics. Butakor (2018) testified that the home is the first environment every child encounter in the learning process. It is, therefore, imperative to consider the environment's importance in terms of the influence it has on the student's cognitive growth and academic achievement, more especially on mathematics achievement. Oginni (2018) believes that the home environment is viewed as consequential for child developmental outcomes such as cognitive ability, school readiness, academic achievement, and emotional adjustment. The learner's background can be measured by the socio-economic status of his/her family. The assumption by Oginni (2018) is that a learner from a higher socio-economic background has advantages over a child from a lesser status and in a higher class there may be a television set, radio, picture, home teacher, home library, computer, reading, and writing materials all of which help to prepare a child for learning in school. Motivation from the parents or family members at home can create a positive attitude for a learner toward learning mathematics. Butakor (2018) noted that socioeconomic status is multidimensional and there are two distinct dimensions. These dimensions are a general economic factor, which includes indicators such as parents' occupation and income, and a cultural capital factor, which includes indicators such as parents' education and home educational resources. The conclusion was that both factors were strongly related to academic achievement.

Ajai and Imoko's (2015) experience was that students have a wrong image of mathematics- that mathematics is many formulae to learn, without knowing why; mathematics is a never-changing, not lively subject; something for nerds and loners, and thus, maybe, also something for boys and men and not for girls and women. Butakor (2018) shares the same view: the stereotyping of

mathematics as a male subject can affect mathematics performance and cause anxiety on the part of females, thereby affecting their interest in mathematics. According to Shepherd (2017), at the level of tertiary education in South Africa, less than 30% of students enrolled for undergraduate degrees in the fields of engineering and computer science in 2012 were women, whilst about half of science undergraduate enrolments were women; this is compared to 65% of all undergraduate students being women. One explanation provided by the report is that the image of mathematics has been constructed as a male domain and that a girl's self-image precludes that of a mathematician. The problem of gender moves further to the working environment where science and mathematics-related jobs are mostly dominated by men. In some households, priority at home must be given to house chores before school work. Language of teaching and learning is another factor to consider when looking at the problems that learners face in mathematics.

Language or communication in mathematics is an important part of mathematics education as a means to exchange ideas and tools to clarify understanding (Rohid and Rusmawati, 2019). In South Africa, the language of teaching and learning mathematics is English, and there are eleven official languages, nine of them being native languages. The majority of secondary learners are native language speakers. So, these learners must understand English as a language before attempting mathematics. Observations have shown that some of the native languages do not have sufficient terminology for the technical terms in mathematics. For Riccomini et al (2015) the ability to effectively communicate (expressively and receptively) through the language of mathematics requires mathematical understanding; a robust vocabulary knowledge base; flexibility; fluency and proficiency with numbers, symbols, words, and diagrams; and comprehension skills. This is a clear demonstration of how the learners' knowledge of mathematics is affected by the language, more especially for second-language speakers. The studies reveal that learners perform better if the language of learning and teaching is the same as the language spoken at home (Vissa, Juan, and Feza, 2015). Not being able to interpret and understand the question will result in a wrong answer and poor performance in the subject. Riccomini et al (2015) mentioned a few examples of categories of difficulties associated with learning the language of mathematics. (a) Meanings are context-dependent (e.g., *foot* as in 12 inches vs. the *foot* of the bed), (b) mathematical meanings are more precise (e.g., *product* as the solution to a multiplication problem vs. the *product* of a company). Madela (2016) agrees that many learners are excluded from performing well because

of their challenges with the language of instruction. In a study done by Rohid and Rusmawati (2019) in Indonesia, the findings revealed that there is one in every third-grade child who can express mathematical ideas; understand, interpret, and assess or respond to mathematical ideas; and use terms, notations, and symbols to present mathematical ideas. The study implies that the students' mathematical communication skills still need to be developed. For Riccomini, Smith, Hughes, and Fries (2015), students' mathematical vocabulary learning is a very important part of their language development and, ultimately, mathematical proficiency. Naidoo's (2016) view is that since learners are required to speak, write, and read like mathematicians to be successful in mathematics, learning in a second language becomes a challenge.

A study done by Geldenhuys, Kruger, and Moss (2013) on selected South African Grade 10 learners revealed that learners commented that they would find certain topics more meaningful if they could watch programs on television, educational videos, or DVDs. They further remarked that they did not have their textbooks and would have liked to possess them. There were also opinions that they would find ML more meaningful if they could use computers in some of their lessons. Vester (2006), as cited by Geldenhuys et al. (2013), notes that, apart from a few recently published textbooks, ML resources are not readily available, and access to resources and textbooks has been a problem. Learners need to see, feel, or interact with the objects or things being discussed in class to gain a better understanding. According to Botha and Putten (2018), the South African conceptualisation of mathematical literacy is dependent on the mathematisation of contextual situations. Goos and O'Sullivan (2023) mention that the lack of school-based curriculum leadership in mathematical literacy, the lack of teacher understanding of how to teach mathematics in real-life contexts, and disparities in access to resources between private schools and poorer public schools threaten to undermine the potential of the ML subject to meet its transformational aims. However, understanding content without context is not the only problem faced by ML learners. The language in which the subject is taught is another challenge facing the learners, more especially, those who are not English first-language speakers.

According to Mbonambi (2013), learners' factors associated with poor performance in ML examination include poor conceptual understanding, misconceptions, and language-related misinterpretations. The style of structuring the subject content of ML as a subject is a problem, as data is presented in a lot of statements (number stories) that require high levels of comprehension

in the learners' second language (Matope, 2022). Matope (2022) further explains that the conceptual complexity and problem-solving nature of mathematics make extensive demands on the reasoning, interpretive, and strategic skills of learners, especially when these activities are done in a language that is not their primary language. On the other hand, Mbonambi (2013) raises a concern that presenting too much unnecessary information about the context constitutes information overload, which distracts the learners from picking out the crucial information that they need. Normally, paper 2 of ML is loaded with such questions where a learner needs to read paragraphs of information before attempting the question. The loss of translation on a given problem will result in poor answering of questions, as one cannot answer what he/she cannot understand. Furthermore, the balance in the context to match the content is itself another problem due to inequalities in education.

The context in which ML is taught must be authentic so that learners can have a better understanding of the topic. Prinsloo (2017), as cited by Frenzel (2021), discovered that learners who live in societies where every day is a constant struggle for survival are not likely to be interested in information that may only be useful to them in some hypothetical future, as they do not see themselves having access to it. For instance, solving a contextual problem about ocean tides is likely to be understood and answered better by a learner living next to the coastline or who frequently visits the ocean, leaving a learner from Limpopo province confused. The idea of tides and how the ocean works is a new concept that a learner must first digest and understand. Failing to understand how the ocean works, probably due to language constraints, may lead to a learner not even attempting the questions that follow. Even for learners with little or sufficient information about the context, confusion may arise in deciding whether to answer according to personal factors and experience or according to what the examiner wants. Frenzel (2021) argues that the standardised nature of contexts in textbooks may also undermine the accessibility of the subject. If the learners cannot understand what is being assessed, they are likely to change their attitude towards the subject, which can lead to poor performance. According to Dlamini (2016), ML is more of a practical nature, and a learner can easily associate what he/she learns in the subject with the world in his/her immediate environment. This also means that different learners from different backgrounds may respond differently to some examination questions. In my observation, this normally disadvantages the learners with less exposure to many different environments. ML also

asks examination questions that require learners to be abreast of current affairs, mostly available in digital media. Learners from rural schools struggle to make sense of such questions as they do not reflect their immediate environment, and they don't have access to such knowledge.

The stigmas associated with this subject somehow make it difficult to keep a positive attitude towards it. It is rather known as a dumping site for poor-performing mathematics students. In many schools in the country, ML is not offered as a positive, open choice for grade 09 learners who move to the FET phase band. Rather, learners are demoted to ML when they struggle with mathematics in grade 10 or 11 (Frenzel, 2021). The study done by Geledenhuys et al. (2013) revealed that mathematically able learners at the end of grade 09 are strongly advised to take Mathematics in Grade 10, while weak and failing mathematics learners are advised to take ML. The result is that the majority of learners who participate in ML lack enthusiasm and interest in mathematics, which is mistaken for an expression of their intelligence or capability (Frenzel, 2021). Learners stated that if one is doing ML, they are viewed as being slow, dumb, and stupid (Madela, 2016). Genc and Erbas (2019) also add that studies show that some teachers consider ML to be a watered-down version of easy mathematics, and it is meant for academically weak learners to perform at school.

Another worrying problem is that learners who choose ML at high school cannot do science-related courses or any course that is mathematics-related at higher learning institutions. Well-known academics have publicly criticised the introduction of ML as being a disastrous experiment because it does not allow learners access to pathways for careers in science or mathematics (Bansilal, 2014). Madela (2016) adds that a learner can lose a lot more than only mathematics if they choose to do ML. When a learner chooses to do ML, they are shutting down all other science subjects. This is a result of a few students who graduate with science and mathematics-related degrees. With problems associated with ML, the emphasis on context when teaching this subject remains a matter of concern. The emphasis on the use of ICT to enhance the education experience has been open for implementation by the Department of Education

2.1.3 Using information communication technology (ICT) in mathematics and mathematical literacy (ML)

Information communication technology (ICT) comprises technologies for manipulative communication of information and also consists of the medium for information recording like radio, television, and others, and technology for communication through voice and sound or images using microphone, camera, loudspeaker, and telephone/mobile phones (Akinoso, 2018). According to Das (2019), the term information communication technology is described as the information dissemination, storage, and management of various sets of technical tools and resources that are accepted for information and communication technologies. Most importantly, ICT allows for the production of digital resources such as digital libraries, where students, teachers, and professionals can access study material and course material from anywhere at any time (Das, 2019). With ICT in education, information can be accessed and shared in the form of multimedia for better meaning. Multimedia is concerned with the computer-controlled integration of text, graphics, drawings, still and moving images (video), animation, audio, and any other media where every type of information can be represented, stored, transmitted, and processed digitally (Akinoso, 2018). Jita and Sintema (2022) conclude that Information and communication technology (ICT) competencies are among the most important requirements to effectively teach mathematics and science in today's classrooms, these ICTs refer to digital resources like tablets, laptops, software, and online tools that are used in educational environments.

For Vadahalam and Chimbo (2017) one of the main benefits of using ICTs in teaching and learning is the use of the web/ internet for referencing and communication. This provides a medium to access online calculators, simulations, and research, and thus contributes to making learning easier and more fun. In a context-based subject like ML, ICT can be very helpful in putting the content as close as possible to real-life situations. Akinoso (2018) adds that the benefit derived from the use of multimedia resources is not limited to the ease of teachers' work alone especially to support constructive concept development, but helps students in such a way that makes them relate the knowledge to real life. With the help of the internet, there is no limit to the number of examples that learners and teachers can access and use to enhance teaching and learning. With ICT learning, learners develop critical thinking,

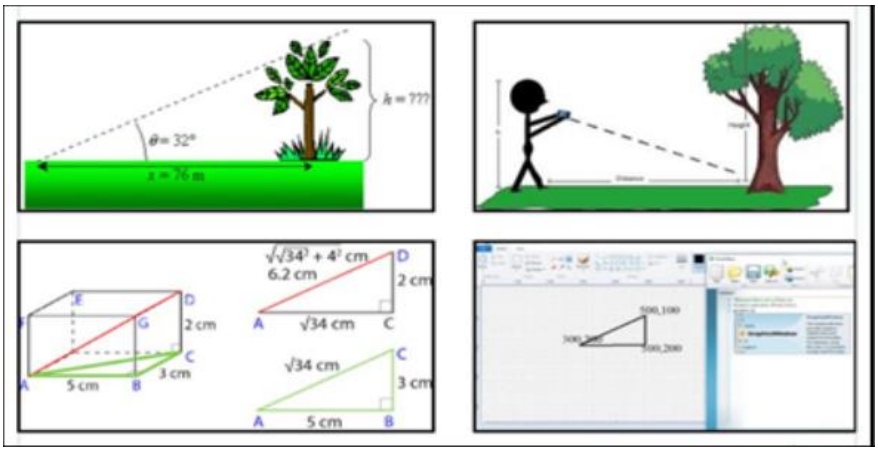


Figure 2.1 Technology integration in mathematics Das (2019)

The picture above shows the height of a tree in daily life and the diagram of the triangle cube, and its calculation is defined, and another image shows the use of Excel (Das, 2019). ICT supports mathematics for composing, revising, editing, publishing, calculating, making connections, visualizing data, finding importance, synthesizing, and problem-solving. Varieties of notations, formulae, symbols, figures, and graphs are available in mathematics which are difficult to demonstrate on blackboard/whiteboard like 2D and 3D figures, graphs and charts, transformation of objects, and other associative matters. By ICT-related applications, tools, and software such matter can be taught expressively (Joshi, 2017). The above figure is an illustration of how ICT can be used to bring mathematics and ML learning into context and make it interesting for learners to engage in.

Studies have shown that using ICT in learning mathematics and ML motivates learners. This is because of its richness in graphical content that can be manipulated to simulate real-life context. Muthulakshmi and Veliappan (2016) discovered that creating the necessary interest is a constant problem for the teacher because the subject demands the use of various aids and innovative methods in teaching. Technology is pervading all levels of mathematics teaching and learning in our modern world. For many students, the integration of ICT into learning mathematics is empowering and stimulating. According to Khalid and Zakaria (2016), an experimental study done by Neurath and Stephens (2006) in a secondary school involving three comprehensive tests using Microsoft Excel revealed a slight increase in students' achievement and their interest in the topic. They enjoyed Excel assignments and increased their overall understanding of algebra, which

blended well with computers and technology (Khalid and Zakaria, 2016). In ML, dealing with complex problems may require the use of content that is trending, and drawn from current affairs. The use of ICT can provide this content, create interest in the subject, and motivate learners to research more about the topic.

ICT learning in mathematics and ML creates motivation to learn which promotes independent learning which makes it possible for learners to learn effectively even at their respective homes. According to Akinoso (2018), multimedia also helps to ease learning by enabling students to learn at home which improves students' learning skills. The benefits of mobile technologies include enabling independent, cost-effective, and student-centered learning at a student's own pace, space, and time (Vadachalam and Chimbo, 2017). Learners' access to information is not only limited to a classroom. Learners can communicate and work together to resolve problems they could not finish in class, and do homework.

Kalid and Zakaria (2016) noted that one of the benefits of applying ICT in the teaching of mathematics is creating interaction among students. Indirectly, the communication that occurs amongst students through the application of technology during the learning process promotes knowledge and information sharing which supports constructive learning (Khalid and Zakaria, 2016). Collaborative learning is often encouraged by educators in mathematics and ML, and with the integration of ICT, such ideas have been carried over beyond the boundaries of a classroom, and as a result, learning groups and communities are created. Peer torturing can be used as another form of collaborative learning. Peer tutoring is a structured, collaborative approach that encourages children to learn from each other (Tsuei, 2017). Chu, Chen, and Tsai (2017) testify that in the past decades, various studies have found that online PT learning systems not only provide opportunities for interactions between students from different countries but also improve students' knowledge construction and general language ability.

Mthembu (2016) explains that the origin of human intelligence is society and culture; therefore, learning that takes place in learners' social and cultural groupings, through social media, could improve their intelligence. Learning through social networks is another form of learning that involves ICT. There is no formal schooling on using social networks, and everyone with a compatible device and internet access can access social networks. Learners do not undergo any

formal schooling to learn how to engage in social networks. They seem to be responsible because learners take an active role in the learning of what is of interest to them via social networks (Mthembu, 2016). This paper reviews a blog as a learning tool for mathematics and ML and how it can improve the learners' performance.

2.1.4 Learning mathematics and mathematical literacy (ML) through the blog

A blog is another online platform that uses the internet to collaborate with people with the same interests for discussions and information sharing. Many definitions have emerged from different scholars and researchers. According to Simangusong and Irvan (2023), a blog is an abbreviation of a weblog which is a type of website developed and maintained by individuals using online software or hosted platforms that are very easy to use. An activity of updating the blog is called blogging, a person who maintains a blog is called a blogger, and a blog is a continuous journey, guided by a continuous and consistent logic (Simangusong and Irvan, 2023). Silalah (2017) describes a blog as a means of delivering information online that has internet features that can penetrate the boundaries of space and time. The defined features of the blog make it ideal for learning mathematics and ML. Ismail, Fitriani, Takdir, Sudirman, and Umar (2020) highlight that the existence of the blog can maximally be used by the teacher as an alternative media in delivering learning material and can also be a solution to fulfill the lack of learning hours in the classroom. Providing access to information and learning is one of the important benefits of using the blog.

Sireger, Frisnoiry, and Andreani (2020) testify that with the use of blogs, learning can be done anywhere and anytime; this is because the advantages of blogs have a high level of flexibility, namely the ease of accessing information, students can review teaching materials at anytime and anywhere, if needed, to remember the material they have learned. Garcia, Moizer, Wilkins, and Haddoud (2019) add that, the authors explained that learners considered blogging as practical, unlimited, and accessible, which are features that are not always found in more traditional forms of education. Such an opportunity can be used by students to engage in discussions about their mathematics and ML homework and engage a teacher in a discussion outside the classroom walls. In addition, Ismail et al (2020) believe that the material in the blog can be made so creative, informative, and up-to-date that the material presented can be accessed anytime, anywhere, and by anyone, by the teacher and students, even from different schools who visit the blog address. This

means learning mathematics and ML can extend to more than one school, even the international level is possible. This encourages collaborative learning.

For Jackling, Natoli, Siddique, and Sciulli (2014), blogs designed for an educational setting have the potential for the student to develop views and contemplate how these views might be interpreted and reflected upon by others in a group collaborative learning environment. Teachers can collaborate and have discussions about improving teaching methods and share teaching resources and information. Learners, on the other side, can collaborate and discuss solutions to problems given in class. Sireger et al (2020) add that learning using a blog is aimed so that students can share information about various matters relating to learning or self-development. Furthermore, Silalah (2017) finds a blog, in the context of learning, a good opportunity to engage students in a student-centered cooperative learning environment, allowing opportunities for knowledge creation and sharing, creativity, reflection, and debate. Jackling et al. (2014) argue that prior studies have demonstrated that blogs have enabled students to improve assignment strategies and enhance learning outcomes, particularly in collaborative learning situations. The informal environment provided by the blog makes it comfortable for students to engage in discussions, which promotes interest in mathematics and ML. Blogs support collaborative learning by enhancing knowledge acquisition, knowledge sharing, and reflective processes (Kuo, Kuo, and Belland, 2017).

Students develop a better connection with their teacher and other students through blogging, which allows them to feel more comfortable on the blog and in the classroom (Silalah, 2017). Learners who do not feel comfortable participating in front of other learners can engage in discussions better in the comfort of their homes and can engage in debates with facts from the sources provided by the links in the blog. Fekasis et al (2017) suggest that teachers can utilize the blog to increase the communication among the participants of the course as well as the level of their participation and the depth of engagement. According to Garcia et al. (2019), Students may be motivated to develop their knowledge and write a blog to gain respect and credit from their tutors and peers, as well as to gain helpful feedback through comments. The literature has revealed that one of the problems in learning mathematics and ML is the interest of the learners in the subject. Using the blog can overcome the problem of learner interest, and poor performance.

At the backbone of the blog, there is the internet which is known for unlimited access to all sorts of information and requires customized browser settings to block unwanted pop-ups and advertisements. The blog has links and hyperlinks that lead to other links, a double-edged sword that can help a learner discover more information about mathematics and ML problems or can lead a learner to information of interest that is not related to the topic for discussion. Different researchers have raised problems concerning the usage of the blog. Sireger et al (2020) believe that the use of blogs often experiences obstacles, and one of them is due to a lack of teacher expertise in utilizing technology. Ismail et al (2020) agree that many educators have not used the blog as a learning medium. It is caused by several reasons, such as the use of English terms in several blogs that are difficult to understand by some students and teachers, lack of knowledge in managing blogs as learning media, and educators that the use of blogs requires knowledge about computers. If a teacher is not technologically competent, a lot of time could be wasted attending to a technological aspect than achieving the goals. Proper knowledge to administer and run the blog is also required from the educator for maximum effect, this includes providing the right and safe links for learner resources and information.

Using the blog can be a fantastic way to improve learner participation in mathematics and ML. Kuo et al (2017) share the same view that research has indicated that blogs can serve as effective teaching and learning tools to support students' active participation through collaboration in a class, enhance peer support and interaction, increase students' motivation to learn the subject content and develop students critical thinking and reflective skills. Even in the classroom environment, blogging can create participative learners with self-confidence. Zheng and Warschauer (2015) mention that studies suggest that pedagogically sound incorporation of digital literacy into classroom practices can potentially lead to greater engagement and motivation by providing an authentic audience for students' writing, allowing students to get rapid feedback from others, and facilitating more equal participation of shy or reticent students.

2.1.5 Challenges of learning through technology

Verities of factors can be found to affect the use of technology in pedagogical practices, like policy-related factors, infrastructure-related factors, human resources-related factors, software and hardware-related factors, and technical factors (Joshi, 2017). In the South African context, power

cuts can be added to the list. Several studies have discovered that, in some cases, teachers are the root cause of implications that come with the integration of ICT in learning.

Amuko, Ndeuthi, and Miheso (2015) believe that teachers' computer competence is a major predictor of integrating ICT in teaching. Evidence suggests that the majority of teachers who reported negative or neutral attitudes towards the integration of ICT into teaching and learning processes lacked knowledge and skills that would allow them to make an "informed decision". Vadachalam and Chimbo (2017) mention that the teachers' lack of confidence can be attributed to several factors such as fear of using ICTs due to lack of skills; Resistance to change and negative attitudes usually exist when teachers either do not understand or believe in the good intentions of ICTs in education; Teachers who have not yet experienced the numerous benefits of ICTs will not be motivated or ready to embrace ICTs in teaching, as they do not foresee any benefits. In addition, skill/experience of teachers, pedagogical and technology knowledge, pedagogical beliefs, access to resources, support from institutions, institutional culture, curriculum & assessment requirements, perceived abilities, motivation and behaviors of students, preservice education program, practicum and professional development of teachers can also affect the proper use of ICT in teaching practices (Joshi, 2017). Vavachalam and Chimbo (2017) also raise a concern about time, that teachers need time to conduct online research and learn how to use and incorporate ICTs into lessons.

For effective ICT learning, there must be an internet connection to maximise communication, data retrieval, and sharing. This makes internet access another problem of using ICT in learning. Because of cost, personal computers are just not as common as in developed countries. There is also an issue of technical barriers; Vadachalam and Chimbo (2017) explain that the technical problem barrier revolves around two major points. Firstly, teachers fear encountering technical problems while using ICTs and being unable to fix them. Secondly, technical support is required for proactive and consistent maintenance of ICTs, but most schools lack any form of technical support.

Another factor that becomes an obstacle to the implementation of ICT in the teaching of mathematics is limited technological resources when teachers or students are at home (Zakaria and

Khalid, 2016) Most schools in rural areas are without ICT infrastructure and the standard of living in homes where most learners come from do not have ICT resources.

2.1.6 Conclusion

Poor performance in mathematics assessment results remains a problem facing South African learners. To address this matter, the Department of Education introduced ML in the FET phase as an alternative to mathematics. The problems included the barriers to language, lack of learning resources, inadequate facilities, attitudes of learners, and teacher knowledge. Other problems were identified to be teacher-specific, meaning the shortfall is from the teacher's side. Poor teacher training is one of the problems the department is facing. Another problem is the continuous change in the curriculum without proper support for implementation. On the learner's side, attitudes, anxiety, and lack of confidence have been identified as some of the challenges. Furthermore, there has been some evidence of poor performance associated with the gender of learners, where mathematics is perceived to be a male-suitable subject and is hard for female learners. Using the blog, which is an online platform, provides learning flexibility. There are opportunities to learn outside the classroom, and access to information anytime and anywhere. The blog also allows collaborative learning, which promotes the creation and sharing of information. Challenges associated with the use of technology in pedagogical practices, like policy-related factors, infrastructure-related factors, human resources-related factors, software and hardware-related factors, and technical factors, were also identified. In the South African context, power cuts, learner socio-economic background, and the distribution of resources at schools determine the feasibility of ICT integration in learning. Lack of teachers' knowledge in the use of ICT is another problem some schools are still battling to overcome.

2.2 Theoretical framework

2.2.1 Introduction

This section discusses the theoretical framework that guided the study. The chapter further discusses different approaches to pedagogy.

2.2.2 Connectivism theory

New theories of learning are emerging to address the explosion of information and the changing nature of knowledge creation, access, and use. In December 2004, Siemens published

connectivism learning theory on his blog, learningspaces.org (Keller and Utecht, 2019). The updated theory was published in April 2005. For Siemens (2004), we can no longer experience and acquire learning. We need to act, and we cannot experience everything. Therefore, other people's experiences become a surrogate for knowledge. With connectivism, learning can reside inside or outside of ourselves; it is focused on connecting specialised information sets, and the connections that enable us to learn more are more important than our current state of knowing (Siemens, 2004). Connectivism is a learning theory that emphasises the importance of social networks and technology in the learning process (Alam, 2023). It can be characterised as a network theory of knowledge and learning with an emphasis on the use of digital technology to enhance and extend interaction online, as noted by Downes (2019). This study follows connectivism as a guiding theoretical framework. To give a better understanding of Siemens 'learning theory, five key points stand out when we try to understand this theory.

(a) Integration of technology

Firstly, the integration of technology in learning is one of the key points on which connectivism is based. The internet and digital tools have led to a shift in ways of information gathering and learning in general. Internet technologies, comprised of databases and search engines, are capable of housing thousands of blogs, news articles, book experts, journal articles, video clips, and podcasts (Kropt, 2013). In the context of education, these new technologies mean new, improved ways of learning for students. However, Keller and Utecht (2019) argue that the power lies not in the technology platforms themselves but in the connections they foster. It can be concluded that connectivism is a digital age learning theory that integrates learning with technology to forge a learning system that is driven by connecting or socialising online. Therefore, it allows the integration of thoughts and information facilitated by technology. In a high school environment such as Thornwood Secondary School, the time allocated for each subject is an hour per day. An hour may not be enough for an explanation of concepts, examples, class activity, and corrections. There is also a need to accommodate learners with different learning styles, bearing in mind the effect of attitudes and experiences of learners. With technology, learning is not confined to the four walls of the classroom or school hours. Information is limitless, and most importantly, learners are in charge of their learning.

(b) Network and Nodes

Secondly, one cannot fully describe connectivism without touching the concept of networks and nodes. Herlo (2016) describes a node as an entity such as a person, group of people, computer, or ideas, and as a community. These nodes carry information as a form of knowledge. Kropt (2013) emphasises that these connections provide individuals with direct access to reliable information from millions of sources to duplicate, reproduce, and share within their social networks, and to delete, critique, and discard inaccurate, irrelevant, and unreliable information. The connection in the nodes is such that a change of data in one node has the capability of influencing the change in another node. When connecting the nodes that share similar interests, you will have yourself a network. The blog for Thornwood Secondary School learners means creating a network of learning mathematics and ML. Connectivism describes learning as an informal opportunity that transforms individuals into nodes themselves, equally capable of sharing their knowledge and expertise with other individuals (Kropt, 2013). Learners who cannot participate freely in class can find comfort in the learning system that allows them to be in control of how they learn. A network of enthusiastic learners with a passion for learning mathematics and ML can go a long way in influencing those learners who have a negative attitude toward these subjects. Furthermore, choosing what information to use from vast databases of information is a learning process on its own.

(c) *Decentralised Learning*

The principle of connectivism is that individuals acquire information through modern-day databases of information. With this in mind, the third key point under discussion is decentralised learning. Unlike old traditional learning methods, there are multiple streams of information. There is no central authority; learners get information from different sources. According to Alam (2023), connectivism posits that knowledge is not only acquired through traditional means such as textbooks or lectures but also online communities, social media, and other technological platforms. Thornwood Secondary School learners, to be specific, can mine their

information from different sources. Learning is autonomous and flexible, and learners' source of information is not the teacher alone.

(d) Dynamic Knowledge

Siemens (2004) made a point worth noting, that if the underlying conditions used to make decisions change, the decision itself is no longer as correct as it was at the time it was made. In the context of education, most schools have not adopted the use of ICT in classrooms. Schools are still using learner textbooks, and for context-based subjects like ML, frequent updates of textbooks are a must. However, the department's budget is not flexible enough to accommodate such updates. At Thornwood Secondary School, for example, learners are still using a textbook that calculates VAT at 14%. Consequently, learners are likely to fail this question in a provincial common examination. However, learners on a network are likely to have identified such change from other learners on a network or have come across such information while browsing through the blog. A discussion or debate about this change may trigger another learner to extract evidence from other sources to back up his/her argument. The whole process is learning itself. Knowledge is not static; what we know may change tomorrow, and staying connected is crucial. This concludes the fourth key point-dynamic knowledge.

(e) Collaborative Learning

Lastly, connectivism's goals are in line with collaborative learning. With the rise of the Internet and the free flow of information, the idea that learning is an individual endeavour that one undertakes alone is no longer true (Keller and Utecht, 2019). Alam (2023) mentions that with the advent of the internet and social media, learners have access to a vast array of information and resources, and can connect with others around the world to share knowledge and ideas. The blog for Thornwood Secondary School learners will facilitate the collaboration of learners from different classes within the school. Furthermore, the blog is open to every learner studying the subjects included in the blog, regardless of the school or location. Only a selected sample will be used for data collection. This will allow learners to collaborate with other learners and possibly other teachers as the blog gains popularity.

2.2.3 Criticism of connectivism

Nonetheless, just like any theory, there has been some criticism of connectivism. Downes (2019) shares information about the early connectivist course that concluded that not all students were able to autonomously direct their learning and master critical literacies. The internet and social networks can be very disruptive for some learners to focus on the topic at hand. Not everyone is technology savvy or likes the complexity that comes with technology. Some of the challenges are evident in the resistance to change and will resolve eventually because the need to adapt to technology is imminent and cannot be avoided. Alam (2023) highlighted that the critics of connectivism have argued that the theory places too much emphasis on technology and social networks and overlooks the importance of other factors such as motivation, individual differences in learning styles, and the role of the teacher.

2.2.4 Different approaches to pedagogy.

Strategies and methods used in teaching and learning are referred to as pedagogy. Approaches to pedagogy can be applied in different situations and environments of teaching and learning. Five approaches are discussed in this section.

2.2.4.1 Constructivist approach

Constructivism is a philosophy of learning founded on the premise that, by reflecting on our experiences, we construct our own understanding of the world we live in (Ngiba, 2020). The idea of the constructivist approach is that learners construct knowledge for themselves rather than passively receiving information.

2.2.4.2 Behaviourist approach

In this learning approach, behaviours are learned through interaction with the environment. According to Kimble (2017), the interest of the behaviourist in man's doings is more than the interest of the spectator—he wants to control man's reactions as physical scientists want to control and manipulate other natural phenomena. It is the business of behavioristic psychology to be able to predict and to control human activity.

2.2.4.3 Cognitivist Approach

Cognitivists' focus is on the mental processes, which include critical thinking, problem solving and memory. The emphasises the learning process rather than the learning

outcomes themselves. Cognitivism focuses on the mind, and more specifically, mental processes such as thinking, knowing, memory, and problem-solving, intending to open the black box of the human mind, the process of which is deemed valuable and necessary for learning to occur (Sharma and. Mahavidhyalaya, 2023).

2.2.4.4 Humanistic Approach

Student-centred learning, motivation, and personal growth are a priority for this approach. Its emphasis on the distinctively human features of human existence, as well as the need to see people as "wholes" rather than "parts," struck a popular chord, and a series of nearly "evangelical" works propelled this approach into the limelight. (Tulasi and Rao, 2023)

2.2.4.5 Connectivist Approach

This approach integrates technology and digital networks to facilitate learning. Alam (2023) explains:

> "Connectivist learning is a relatively new approach to learning that emerged in the early 2000s with the advent of social media and online learning platforms. It is based on the idea that learning is an ongoing process that occurs through connections between people, information, and technology. This approach emphasises the importance of building networks and creating connections between learners, resources, and ideas."

Each approach is unique and has it strengths and can be blended for effective teaching

2.2.5 Conclusion

Connectivism is a learning theory that emphasises learning using the Internet and social networks. It is based on the idea that knowledge is not simply acquired, but rather it emerges from connections made between a network of individuals, ideas, and resources (Alam, 2023). Connectivism recognises that information is dynamic; therefore, learners must be able to adapt to changing circumstances and continually seek out new knowledge and experiences. Lastly, connectivism facilitates collaborative learning amongst learner. Different pedagogical approaches can be blended for effective teaching and learning.

2.3 Summary of the chapter

The chapter gave a discussion of the challenges of Mathematics and Mathematical Literacy, Teacher and Learner problems regarding these two subjects, using Information Communication Technologies in Mathematics and Mathematical Literacy. It further discussed learning mathematics and mathematical literacy using a blog and also looked at the challenges of learning through technology. This discussion drew inferences from other scholars who had done studies in similar contexts. The second part of the chapter looked at Connectivism as a learning theory that guided this study. The different pedagogical approaches were discussed under the theoretical framework section.

3. CHAPTER 3: DESCRIPTION OF RESEARCH METHODOLOGY

3.1 Introduction

This chapter will explore the research paradigm that underpins the study and justify the choice of using the paradigm. This chapter will also highlight why the paradigm of choice is relevant to the study of using the blog to improve the results of the learners of Thornwood Secondary School. The research design will be covered in detail, followed by the approach used. The sampling methods used will be explained in this chapter and the data collection methods used will also be presented. Ethical issues to consider before this research is done will be discussed. The study's trustworthiness will also be discussed in detail in this chapter. The limitations of the study will also be discussed in this chapter. Lastly, the theoretical framework of the study will be explained in this chapter.

3.2 Research paradigm

A paradigm is made up of certain philosophical assumptions that shape and direct our thinking and actions, and it also involves educational and psychological research, which helps the researcher to direct their thinking (Zuma, 2016). A research paradigm represents a particular worldview that informs what is acceptable to research and how research should be done (Bertram and Christiansen, 2020). Bertram and Christensen (2020) note that working with a particular paradigm determines certain choices that include: the kind of research questions that are asked, what can be observed and investigated, how to collect or generate data, and how to interpret the findings. The most common paradigms in research are positivist, interpretive, and critical paradigms; this study will be guided by the critical paradigm.

The philosophy behind the critical paradigm is critique and transformation, which can be done through the product (findings of the research), the research process, or both. According to Asghar (2013), the critical paradigm is three-dimensional and must be explanatory about what is wrong with current social reality, it must identify the action to change it, and it must provide both clear norms for criticism and transformation. The study follows the dimensions with a researcher identifying the problem of poor performance in mathematics and mathematical literacy (ML) in his school and choosing to study the grades he teaches for better understanding. The grades include

grade 9 to grade 11. Secondly, after identifying the problem, the researcher then proposes the use of the blog as an action to change what is wrong with the current social reality he is facing. Lastly, the research findings, the research process, or both will give a researcher the power to transform the current situation or an idea of what should be done to transform the current situation if the proposed solution is ineffective. Pillay (2013) adds that the critical paradigm is based on the use of critique as a method of investigation that seeks to confront all forms of discrimination and injustices so that society becomes more just, humane, and rational. As a result, understanding the challenges that lead to learners not performing well was the first step of the study before proposing a solution for the research. Going through the literature gave the researcher a clear understanding of the problem.

The Critical paradigm sees all social, political, cultural, and economic realities as being shaped by power. Therefore, what we claim to know about the world is always subjective, influenced by our own place in society, our values, etc. (Bertram and Christensen, 2020). The problem of poor performance in mathematics and ML stems from different sources, the social background of learners being one of the sources. The attitudes and values were also identified as one of the problems leading to poor performance in these learning areas. Furthermore, schools with fewer resources are the most affected in terms of poor performance.

Research in this paradigm focuses on bringing about some kind of social change that will benefit those groups who are understood to have little power, or fewer opportunities or choices open to them. These may be due to their sex/gender (they are women), their race (they are not white), their class (they are labourers and not owners of production), or their sexual orientation (they are not heterosexual) (Bertram and Christensen, 2020). The literature also revealed that society views mathematics as a subject that is for male learners. Female learners are often looked down upon when it comes to mathematics. The socio-economic background of learners also had an impact on poor performance.

Bertram and Christensen (2020) argue that within the broad category of critical research, it is possible to identify two non-exclusive streams. The one stream of research aims to bring about change through the product of the research (i.e., the analysis, theoretical concepts, and findings). The second stream of research focuses on the process of the research (i.e., how the research is

conducted, what methods are used, how participants are involved, and the kinds of skills and knowledge that the participants gain as a result of their involvement). The objective of this study is to explore whether the use of blogs can improve the results of learners. Through this paradigm, the findings will determine if the learners using the blog did improve their results after using the blog. Analysis will be done through the comparison of results to those learners who are not using the blog and the results before and after using the blog. The second objective of this study is to explore the perceptions and experiences towards using the blog. The second stream of the critical paradigm will focus on the process of the study by interviewing the participants through focus groups interviews.

In some critical studies, it is seen as important that the participants of a study become researchers who make decisions in the research process. For instance, instead of an outsider coming in to research a particular school or community, the educators in that school or the members of that community become co-researchers in dialogue with the outsider. This reflects an understanding that data can be best generated by informed insiders (Bertram and Christensen, 2020). In this study, the researcher is an educator of mathematics and ML, and the study made use of participants who are learners from the school where the researcher is employed. The sampling methods used are purposive and convenient sampling. The blog uses digital tools that some of the learners may not have. Therefore, it was important to choose those learners who have the right tools for the study.

3.3 Research design

This section discusses the research design adopted by the study.

3.3.1 What is action research?

Action research is an ongoing cyclic process that includes planning, observing, acting and reflecting, intended to reshape prior ideas about a situation (Dolapcioglu and Doğanay, 2020). The important distinguishing characteristics of action research it is a process that improves education by incorporating change and involving educators working together to improve their own practices; it is collaborative and participative, since educators are integral members of the research process; it is practical and relevant, allowing educators direct access to research findings; and, it focuses on critical reflection about professional practice (Mertler, 2021). Furthermore, action research

generally consists of a cycle of action and reflection. This cycle or spiral consists of four steps namely: strategic planning; taking action and implementing the plan; observation, evaluation, and self-evaluation; and reflection on the process and making decisions for the next cycle of action research (Bertram and Christiansen, 2020). Engaging in a second cycle of action research is determined by the success of the first cycle. These cycles can continue until the researcher is satisfied with the outcome or has met the objectives of the research.

3.3.2 Characteristics of action research

Four key points stand out when scholars and researchers define or mention action research. Action research is collaborative, seeks to address a problem, and increases awareness which leads to the change in practice and, which leads to the development of theories.

(a) *Collaborative*

Action research may include a group of researchers interested in the change of practice in which one or two researchers are involved. They then collaborate to reach a solution that will be beneficial to all of the group members. In education, there can be several teachers facing the same problem of poor performance among mathematics students. The solution derived from that research can be applied to all the learners of the teachers involved. Collaboration in action research has been defined both as university and school researchers partnering for action research and as a team of practitioners doing independent action research (Gordon and Solis, 2018). The practitioner is the one who remains and implements the changes when the research is done, while the researcher returns to their principal place of work. Mat Noor and Shafee (2020) add that action research and collaboration are closely interlinked since the action research process is considered successful when it involves a collaborative structure and actively supports the teacher-researchers' development.

(b) Problem

For action research to take place, there must be a problem. The problem depends on the situation or setting. Elg, Gremyr, Hslldorsson, and Wallo (2020) explain that problems are rooted in their social and cultural background, so the researcher needs to move toward the

specific problems encountered in particular cases. The goal is to identify a researchable problem. In this paper, a problem is the poor performance of learners in mathematics and ML. With action research, a problem may be identified at the beginning, and other problems may arise during the process of the research. The solution to the problem may itself become a problem. In that case, a researcher may keep repeating the cycles until the desired outcome. The proposed solution for the problem of poor performance is using the blog. The blog itself requires digital tools and knowledge of using digital tools. That might pose a serious problem for learners who have no access to digital tools and who are not familiar with the use of technology gadgets. Nonetheless, it is important to have the right tools to identify the problem. In most cases, data collection or generation tools can be used to identify the problem. In the case of this study, an observation in the trend of learners' performance by the researcher led to him identifying the problem that required to be studied further to come to a solution.

(c) *Change in practice*

A teacher may decide to try to change her way of teaching to allow for more critical learner thinking. Systematically observing their practice, changing their practice, and reflecting on the process and results would constitute action research (Bertram and Christensen, 2020). The change in practice can bring some benefits to education. Henthorn, Lowden, and McArdle (2024) argue that the benefits of using practitioner research, being engaged with research as encouraging self-critique and reflection on teaching practice, stimulating innovative ideas to inform teaching and learning, and encouraging teachers to look beyond their school and gain a wider perspective. The change in practice is also an advantage to the participants of the research or learners in the case of educational research. According to Henthorn et al. (2024), teachers also reported benefits of research for learners as being improved achievement and attitude, often as a result of teachers using research evidence to create more varied and innovative lessons that engage learners.

(d) Development of theories

The findings from one researcher can be used and applied to solve similar challenges that other people may encounter. In teaching, completed action research projects could provide an evidence base for other teaching professionals to adopt specific adaptions, methods, or strategies (Henthorn et al, 2024). Elg et al. (2020) add that any action research project involves the elements of problem identification and theorization, which are the guiding concepts for dealing with the problem and intervention. Furthermore, Elg et. Al (2020) explains theorizing as the process that is concerned with understanding, defining, and theoretically refining the practical problem and that plausible theoretical ideas are developed as a means for linking the problem to the development of guiding concepts that may solve it.

3.3.3 Action research in education

According to Bertram and Christiansen (2020), action research in the school environment is based on the view that teachers should do their research. It is based on the assumption that teachers know best what is happening in their classrooms, and therefore are the best people to do classroom research. Mertler (2021) adds that in educational settings, it is a process that allows teachers to study their classrooms in order to better understand them and to be able to improve their quality or effectiveness. Poor performance in both Mathematics and ML is a problem faced by both the learner and the educator. The educator who is also a researcher in this study proposed the use of the blog to address this problem. The educator will work in collaboration with learners, who will be the participants, to establish whether the use of the blog can help address the problem of poor performance. Here, the participants or sources of data and the researchers are the ones who experience the problems; therefore, the results of the action research can yield high-quality strategies (Feyisa, Feyisa, Moreda, and Yosef, 2023). In action research, teachers have the opportunity to exercise agency, identify challenges, and overcome problems that are specific and grounded in their context (Emam, Hilal, Mohamed, and Al-Mahdy, 2023). Furthermore, Feyisa et al (2023) suggest that conducting action research in the school is essential for delivering quality education because it enables teacher-researchers to collect relevant data from real sources and situations as well as evaluate the findings by implementing them immediately. More explanations

of action research in education define it as a method of empowering and improving educators' way of teaching for better results. However, in this study, an educator identifies the problem and proposes a solution for a blog. The use of action research is aimed at answering the questions he is faced with after proposing the solution. Firstly, the researcher needs to answer the question about the learner's perceptions and experiences towards using the blog. The second question is, what are the key challenges of using the blog? Lastly, can using the blog in learning mathematics and ML help improve the learners' results? These questions will be addressed during the process of the research and as a final product of this research. One teacher's work might serve several people because action research deals with the everyday work of teachers and the problems they could face in the classroom as well as in the school (Feyisa et al. 2023). Action research provides a structured process for customizing research findings, enabling educators to address specific questions, concerns, or problems within their own classrooms, schools, or districts (Mertler, 2021).

3.3.4 Action research in the context of the study

The participants in this research are the educator who is also a researcher and the learners of Thornwood Secondary School. This research involves 2 phases, each involving the cycles of action research. Phase one will be conducted face-to-face at Thornwood Secondary School, and Phase 2 was run online over the internet. There was no physical contact with learners.

Phase 1 Creating the blog (5 Days)

In this phase, learners create a blog using Blogger, which is a website that allows users to create, customize, and personalize their blogs without advanced IT skills. Signing up requires a Google account that all Android software users have. This phase aims to introduce the learners to the idea of a blog, its look and feel, and how it works. The educator facilitated the introduction with the use of a projector for demonstration. Signing in, followed by customization of themes and coulors. The terms and conditions of using Blogger were summarised for learners to understand. Figure 3.1 shows the cyclical model of action research that shaped this study.

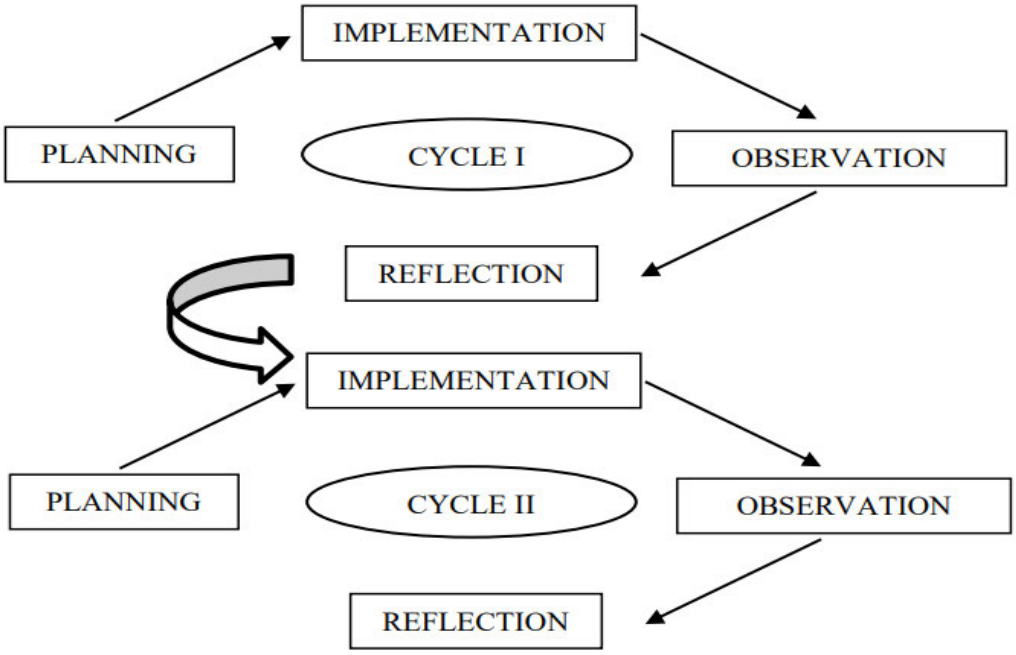


Figure 3.1: A cyclical model of action research

The learners who participated in this research were not familiar with using a blog. As a result, the planning process in this phase involved drafting a program of training learners on how to create, customise, and run the blog. Akinoso (2018) mentions that integration of information and communication technology is not sufficient to ensure that learners learn, there are some other things to put into consideration, such as the use of this tool, i.e., whether the teachers are using the tool or not, adequate knowledge of how to use the tool and when to use it, especially for the subjects that pose conceptual difficulties such as mathematics and science. Data was collected through this process; therefore, it is important to plan for the right tools for collecting the data. in this case, a questionnaire was administered. Implementation involved learners creating blogs on their devices. This involved customisation such as design, themes, colours, fonts, and other visual effects of the blog. The data analysis and results collected before and after this phase were used to make decisions on where to move to the next phase or repeat the phase. It is of critical importance that participants get a grasp of how to operate the blog. The perceptions, experiences, and challenges may vary from learner to learner; however, the basic knowledge of use is important. Once the researcher was satisfied that moving to phase 2 is feasible, the well-designed blog selected from the learners' design was used by the researcher as the main blog that was going to used throughout

the study. The blogs created differ according to learning areas. Each grade had its own page, and learners chose the page relevant to them.

Phase 2- Using the blog (3 Months)

To run and facilitate the blog, information communication technology must be present, and it must form the backbone of the whole operation. Information communication technology comprises technologies for manipulative communication of information and also consists of the medium of information recording, like radio, television, and others, and technology for communication through voice and sound or images using microphones, cameras, loudspeakers, and telephone/mobile phones (Akinoso, 2018). In this study, the participants who were chosen were owners of cell phones or tablets with internet capabilities. Participants were purposively selected on the basis that they have cellphones, tablets, laptops, or a PC with internet access at home. The language of the blog is informal; however, learners may avoid using strong and harmful language. Harmful content, such as images, videos, text, or any other material that is not related to learning mathematics and ML, must not be posted on the blog. Data was collected during the implementation of the blog using focus group interviews for descriptive data about the challenges of the blog and to make improvements if necessary. Informal weekly tests were administered as part of the school curriculum policy, which also includes formal assessments such as assignments and examinations. The data collected from such activities was useful in analyzing the effectiveness of the blog. This was achieved in two ways. Firstly, the results of learners using the blog were checked against their results before using the blog. The aim was to establish if there is any trend of improvement in the results amongst the learners who are using the blog. Secondly, a comparison of learners using the blog with those who are not using the blog was done by a researcher.

In the observation cycle, also called the analysis phase, researchers carefully examine and analyse their data (Harerimana, 2017). The researcher carefully examined and analysed the data from the focus group interview conducted during the implementation cycle to establish the experiences and challenges of the learners towards the blog. A questionnaire handed out after implementation was analysed with interest in the challenges of the learners. The analysis of focus groups interviews helped the researcher get descriptive information from the learners about their experiences and difficulties of using a blog. Zuma (2016) testifies that in qualitative research, group discussion is

one of the useful methods of generating data. Lastly, each educator keeps the record of activities such as informal tests, and formal assessments such as assignments and examinations. This data was analysed to measure the effectiveness of the blog by making (i) a comparison of the learners' results before using the blog and after using the blog, and (ii) by making a comparison between learners using the blog and the ones not using the blog. Though a researcher may not accurately conclude that the improvement is related to the use of the blog, analysing the data from focus groups and questionnaires brought him close to that conclusion.

3.3.5 Action research issues

Educators in action research need to understand that it requires a great deal of planning. Action research is time-consuming which may compromise the teaching time. In a study by Feyisa et al. (2023) lack of training, lack of information on how to engage in conducting action research, lack of time, and lack of practical knowledge were among the challenges that educators mention about conducting action research.

Theoretical rigor is another challenge with action research. Action research is sometimes criticized for lacking theoretical rigor because the researcher is the one interpreting the results. In this study, the improvement of results due to the intervention of a blog may seem admirable to the researcher. This may hinder the interpretation of the results by the researcher. Mabuza (2018) suggests sharing generated data with critical colleagues and supervisors promotes quality and ensures that what is gathered is robust and without bias. The results analysis for this study went under review by the colleagues who are currently conducting their research studies at the university and the supervisor and his team to ensure validity.

Action research findings are difficult to generalize. Factors such as subjectivity, sample size, and context make it difficult to generalize the findings of the research. Kuran's (2023) view is that action research fosters active engagement between the researcher and participants, creating an environment where the risk of biased conclusions exists. This can impact the objectivity of the research findings. The sample size for qualitative data findings may not be enough to generalize. Lastly, the findings from this study may not yield the same results when applied to learners from another school. This issue lies in the fact that action research findings are context-based. In this

study, though findings cannot be generalised, validation of the study was invested more in data collection methods and research design. The use of qualitative and quantitative data was used to strengthen validity.

3.4 Research approach/ style

Ndimbovu (2021) describes the research approach as strategies, processes, or techniques utilised in the collection of data or evidence for analysis to uncover new information or create a better understanding of a topic. Different approaches are available and their methods of collection, analysis, and presentation of findings differ. Some styles of research collect quantitative data, and others collect qualitative data. Some styles of research collect both kinds of research. (Bertram and Christiansen, 2020). This study adopted a mixed-method approach. According to Creswell and Creswell (2018), in mixed method qualitative data tends to be open-ended without predetermined responses while quantitative usually includes closed-ended responses such as those found on questionnaires of psychological instruments. This methodology originated around the late 1980s and early 1990s, in its current form based on work from individuals in diverse fields such as evaluation, education, management, sociology, and health science. Due to the phases that this study went through, a more complex mixed-method approach design known as mixed-method evaluation design was selected. This method consists of one or more core designs added to the steps in an evaluation procedure typically focused on evaluating the success of an intervention, a program, or a policy (Creswell and Creswell, 2018). Figure 3.2 shows how the multiple-core mixed-method designs will be applied in the action research design.

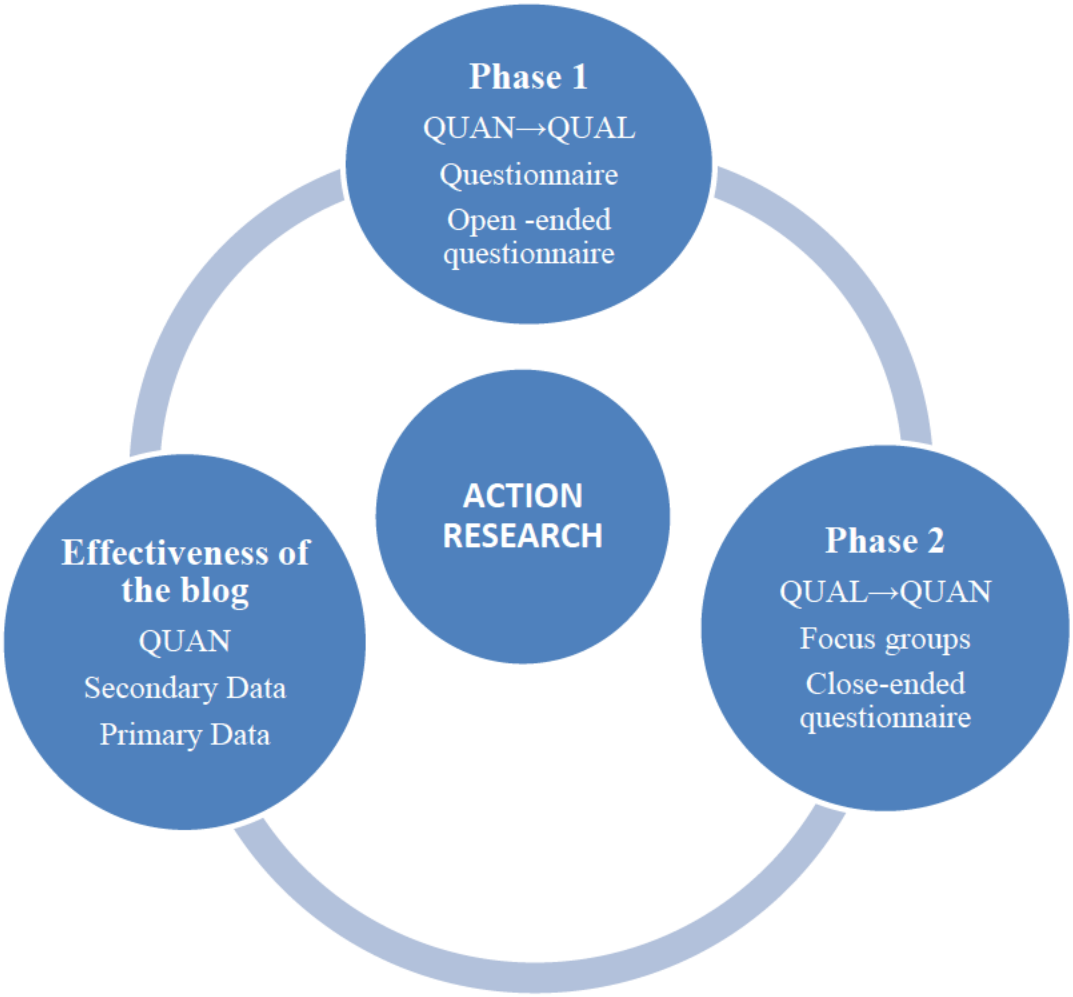


Figure 3.2 Mixed-method evaluation design

The rationale behind this design is the flexibility and ability to blend with the phases of action research to answer the research questions. In phase 1, the researcher follows the explanatory mixed-method design by collecting quantitative and following up with descriptive qualitative data. In this phase, the researcher introduces the blog to the learners and wants to know descriptive information about their expectations and experiences.

In phase 2, during the intervention, focus group interviews was conducted to learn about the challenges and improve or make necessary changes to the blog. Lastly, quantitative data was collected using a questionnaire to collect data about the experiences of the learners.

To measure the effectiveness of the blog, the study adopted quantitative methods by using and comparing secondary and primary data from assignments and formal tests.

Another reason for the mixed-methods approach in this study was to eliminate biases and avoid the weakness that arises from using a single method. Creswell and Creswell (2018) mention that early thoughts of multiple methods resided in the idea that all methods had biases and weaknesses, and the collection of both quantitative and qualitative data neutralised the weaknesses of each form of data.

Nonetheless, one of the challenges of mixed-methods design is how to use the information from the initial qualitative phase to build or identify the quantitative feature in the second phase, also known as an integration point (Creswell and Creswell, 2018). However, the use of both the open-ended questionnaire and focus group helped to get the most relevant information from the given sample. Secondly, qualitative data is likely to be collected from a small sample compared to a quantitative sample. To mitigate this challenge, Creswell and Creswell (2018) suggest that a good procedure is to draw both samples from the same population, but make sure that the individuals for both samples are not the same.

3.5 Sampling

This research took place at both physical and remote locations. Phase 1 was conducted in a classroom at Thornwood Secondary School, and phase 2 (the blog) was run online. The people from whom data was collected are Thornwood Secondary School Grade 9-11 mathematics and mathematical literacy (ML) learners. The learners learned to create and use the blog. They then used the blog to learn mathematics and ML better through collaborating and sharing subjects' content and information. The researcher, who is also an educator, gathered and analysed the data throughout the process to get a better understanding of the learners' perceptions and experiences and make improvements to the blog.

A sample of 50 learners was selected from the population of 186 learners from grades 9 to 11. For qualitative data collection, 20 mathematics learners were purposively selected at grade 9. Grade 10 purposively selected 5 mathematics learners and 10 ML learners, summing up to 15 learners in total. Grade 11 followed the same logic, with 5 mathematics learners and 10 ML learners,

purposively selected. Pillay (2013) describes purposive sampling, as a non-random sampling technique where the researcher specifies the characteristics of the population of interest and locates individuals who match those characteristics. In this study, learners were selected on the criteria that they have a cell phone, tablet, laptop, or PC at home with internet access to access the blog.

A total sample of 50 learners was conveniently selected for quantitative data collection. A comparison of primary and secondary data was conducted at two levels. The first level was a comparison within the sample of 50 learners. The second level included a comparison of a sample to a population of 167 learners in total. These learners were selected because they are easily accessible and they are in the same schools that the researcher teaches in. Convenience sampling refers to the choosing of the participants on the basis that they are near and are available for the task (Zuma, 2016).

3.6 Data collection, generation methods

The four distinct methods this study adopted are open-ended questionnaires, close-ended questionnaires, focus group interviews, and primary and secondary data.

Closed-ended Questionnaire

The researcher needed to plan how he was going to introduce the blog to the learners in a holistic manner. Therefore, the data collection process started with a questionnaire aimed at developing knowledge of how familiar the learners are with the blog. This assisted the researcher in preparing introduction lessons that accommodated all learners according to their level of knowledge and exposure to a blog. Furthermore, the researcher also collected data about the perceptions of the learners about the blog. A second questionnaire was handed out towards the end of phase 2 to collect and analyse data about the experiences and challenges that learners came across from using the blog.

Open-Ended Questionnaire

Descriptive data reflecting on an introduction lesson of a blog was collected using an open-ended questionnaire. This data reflected on learners' perceptions and experiences after training, and determine if the researcher should move to the following phase of running the blog.

Focus group interviews

Focus group interviews were administered in parallel to the blog. The researcher needed to administer the blog with these interviews and get data about the experiences and challenges of learners who used the blog. This data was also used to form the last questionnaire that collected qualitative data from the learners.

Secondary Data and Primary Data

When researchers use various documents, such as examination papers, teachers' daily journals, learners' workbooks, policy documents, curriculum statements, textbooks, etc., as their source data, they are using secondary data (Bertram and Christiansen, 2020). In this study, the records of learners' formal and informal assessments were analysed to test the effectiveness of the blog for those who are using it. Primary data was the data collected for research purposes. A test was administered at the end of the blog to provide a researcher with data to use in making comparisons.

3.7 Ethical issues

Before the study, researchers need to obtain the approval of individuals in authority (e.g., gatekeepers) to gain access to sites and to study participants (Creswell and Creswell, 2018). A letter to request approval from the principal was issued by the researcher, and permission was granted. The content of the letter involved the details of the institutions in which a researcher is registered, the name of the degree, and the title of the research paper. It also specified that the research will use the records of learners' assessments and will also collect data from the learners. The collection, handling, storage, and disposal of data will be carried out according to the regulations of the university.

The study collected data from minors, and with that in mind, the researcher had to issue a letter of consent to the parents or guardians responsible for the learner. The letter guaranteed the protection of the participant's identity, that their participation was voluntary, and they could withdraw anytime without any penalty. The safekeeping and disposal of data will be carried out according to the rules of the university, and the participants were made aware of the questionnaire and an invitation to a focus group meeting.

Mshengu (2019) emphasises that the fundamental ethical concern in any research involving humans is avoiding harming them and further treating participants fairly and respectfully. The rules of the blog were defined as early as possible to avoid issues like cyberbullying and the use of harmful language. Users failing to follow the rules of using the blog will be banned from participating. Sensitive questions and language were avoided when administering the questionnaire and focus group interviews. Lastly, the study went through the university research committee before approval to collect data.

The terms of use of the blog were clearly defined to address the issues of privacy and dignity. Participants need to avoid using the blog in a manner that will violate other participants' rights, including cyberbullying.

3.8 Trustworthiness

Bertram and Christiansen (2020) make it clear that we generally do not judge the research to be valid or invalid, reliable or not reliable, trustworthy or not trustworthy; rather, we ask to what extent is research valid or reliable? Mohammed (2013) adds that it is believed that using different types of procedures for collecting data and obtaining that information through different sources (learners, teachers, program staff, etc.) can augment the validity and reliability of the data and their interpretation. As a result, this study adopted a mixed-methods approach to collect qualitative and quantitative data. Mohammed's (2013) view on triangulation is that the researchers can obtain information through different procedures to heighten the dependability and trustworthiness of the data and their interpretation. Hence, the combination of focus group interviews and a questionnaire.

The data that was used for measuring the blog is marked by educators and moderated by heads of departments before being captured in the school system for validity and reliability. Both open-ended and closed-ended questionnaires and focus-group questionnaires were reviewed by the supervisor and the ethics committee of the university. Based on the reviewer's comments, the unclear and obscure questions can be revised, and the complex items reworded (Mohammed, 2013). A pilot study was conducted on a small group of participants to test the data collection. Member checking was also done to ensure that the data recorded by the researcher was exactly how the participants responded.

3.9 Limitations

Selecting learners with digital tools as participants was a selection criterion. However, another condition is that the learners must have airtime data to access the blog. Some learners may not be able to participate. Secondly, other learners may be distracted by online activities and become reluctant to participate in the blog. However, the use of focus groups during the period of running the blog helped resolve some issues that would arise from using the blog.

3.10 Summary of the chapter

The critical paradigm resonated with action research design and mixed-methods evaluation design. Characteristics and issues of action research were discussed, and action research in education and the context of this study were explained. Data collection methods and the sequence in which data were collected were explained, and the supporting diagrams were used for demonstration. Lastly, ethical clearance issues, trustworthiness, and limitations were explained.

4. CHAPTER 4: RESEARCH RESULTS

4.1 Introduction

The research design and data collection techniques were discussed in the previous chapter. The reliability and validity of this research are also explored in the last chapter, including ethical issues. This chapter focuses on presenting the results of data collected from the participants using the techniques discussed in Chapter Three. The study's objective is to explore the learners' perceptions and experiences towards using the blog and to explore if the use of the blog can improve the results of Grades 9 to 11 for mathematics and mathematical literacy (ML). The study is built on the premises of the connectivism theory by Siemens (2004). This study followed an action research design, with two phases consisting of four cycles per phase. This study adopted a mixed-method evaluation design.

A sample of 20 mathematics learners from Grade 09, 5 mathematics learners from Grade 10 and 5 from Grade 11, and 10 mathematical literacy (ML) learners from Grade 10 and another 10 from Grade 11 were purposively selected to participate in the study. Consent from the parents and guardians was obtained, and all selected learners participated in the study.

To follow the mixed-method evaluation design, the first phase involves collecting quantitative data and a follow-up with qualitative data to get more descriptive data. A closed-ended questionnaire was handed out to the participants to gain the ICT background of the participants and their perceptions about the blog. At the end of the phase, an open-ended questionnaire was handed over to the participants. During the second phase, focus group meetings were held to address any challenges associated with using the blog. At the end of this phase, a closed-ended questionnaire was handed to the participants for quantitative data collection. Cross-checking of learners' results was conducted to explore if there were any improvements resulting from the use of the blog.

The data is presented in text and graphs are generated using Microsoft Excel and SPSS. Qualitative data was analyzed using thematic and content analysis with Microsoft Word. The results are presented in phases, following the mixed-method evaluation design.

4.2 Presentation of results

This section presents the results of the study

4.2.1 Phase 1- Closed-ended questionnaire (quantitative results)

The results presented in this closed-ended questionnaire include the learner's ICT background knowledge and perceptions about the blog. A trial to test the format, language, and use friendliness was conducted on five groups of students, each selected from the existing samples. Participants were battling with the wording in question 1.1.1 **what type(s) of ICT devices do you use?** The question had to be rephrased to **"What type of Technology device do you have or use (you may select more than one)".** Participants were informed that they could select multiple options if applicable.

4.2.1.1 Types of ICT learners have

Out of twenty selected learners, 19 responded to a questionnaire. One learner (5%) confirmed having a personal computer at home, while most (95%) used a cell phone. With Grades 10 and 11 learners, a cell phone was their only ICT gadget.

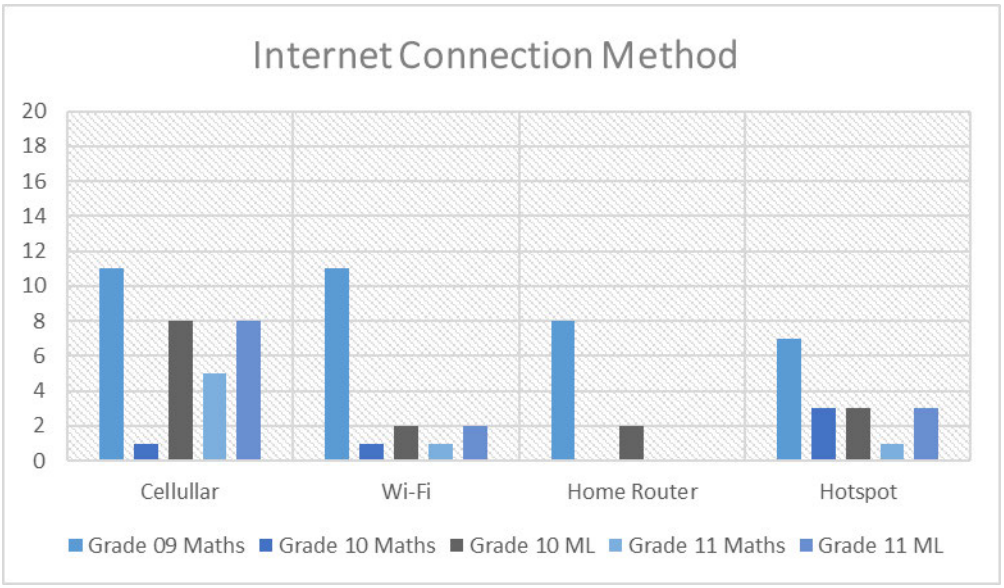


Figure 4.1 Method of Internet Connection

Grade 9: Multiple sources of internet connection were selected by grade 9 respondents (N=19). The rate of respondents who used "Cellular Data" and the rate of respondents who used "Wi-Fi Hotspot" was the same (58%). Respondents (42%) revealed that they also use "Home routers/modems" for internet connection. The option of "Hotspot by Friend/Family member" was identified by 37% of respondents as a method of internet connection.

Grade 10: Five respondents (N=5) were given the option to select more than one source of internet connection if applicable. On three occasions respondents (60%) selected Hotspot by Friend/Family as the source of internet connection. Connecting using cellular data and Wi-Fi hotspots were both selected once (20% each). No respondent used a home router/modem for internet connection (0%). A large percentage of ML learners (70%) confirmed "Cellular Data" as one of the methods of accessing data, while 30% accessed the internet via "Hotspot by Friend/Family Member".

Grade 11: All 5 respondents (N=5) from a grade 11 mathematics sample selected cell phone data as a method they use for internet connection. More options were selected from the list, with 20% selecting Wi-Fi hotspots (public library, mall, etc.), and another 20% selecting Hotspot by Friend/Family member. No learner had access to the home router/modem. Different methods of accessing data were identified by ML participants, with 80% of respondents using cellular data, 20% and 30% using "Wi-Fi hotspot (e.g., Public Library, mall, etc.)" and "Hotspot by Friend/Family member", respectively.

4.2.1.2 Sufficient knowledge of using the Internet and social media

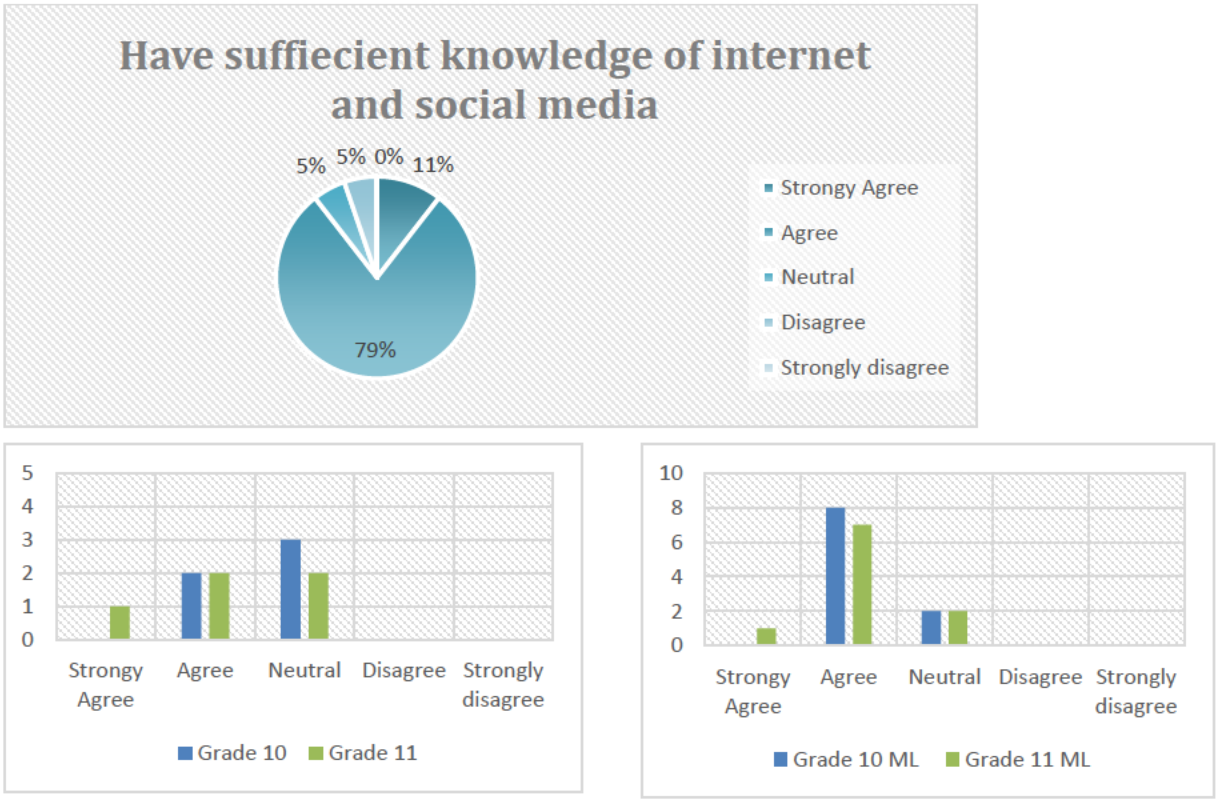


Figure 4.2 Knowledge of the Internet and social media

Grade 9: A very small percentage (5%) of respondents were "Neutral", and only one learner (5%) was revealed to have no sufficient knowledge of the internet and social media. The majority of respondents (79%) "Agree" to have sufficient knowledge, and the remaining respondents (11%) "Strongly Agree" to have sufficient knowledge of the internet and social media.

Grade 10: Out of 5 respondents (N=5), 2 (40%) "Agree" that they have sufficient knowledge to use the internet and social media. The remaining 3 (60%) were "Neutral" regarding their knowledge level. ML respondents "Agree" to have sufficient knowledge of the Internet and social media. The majority (80%) of ML respondents "Agree" to have sufficient knowledge of social media and technology. Only two learners (20%) from the sample were "Neutral".

Grade 11: A single respondent (20%) from the mathematics sample of 5 (N=5) "Strongly Agree" to have sufficient knowledge to use the internet and social media. Two respondents (40%) were

"Neutral" and the remaining two respondents (20%) "Agree" to have sufficient knowledge. Two of the respondents (20%) did not show confidence in their knowledge. They chose to be "Neutral". Nonetheless, one respondent (10%) "Strongly agreed" to have sufficient knowledge of social media and the Internet

4.2.1.3 Have visited the blog before and have a basic understanding of how it works

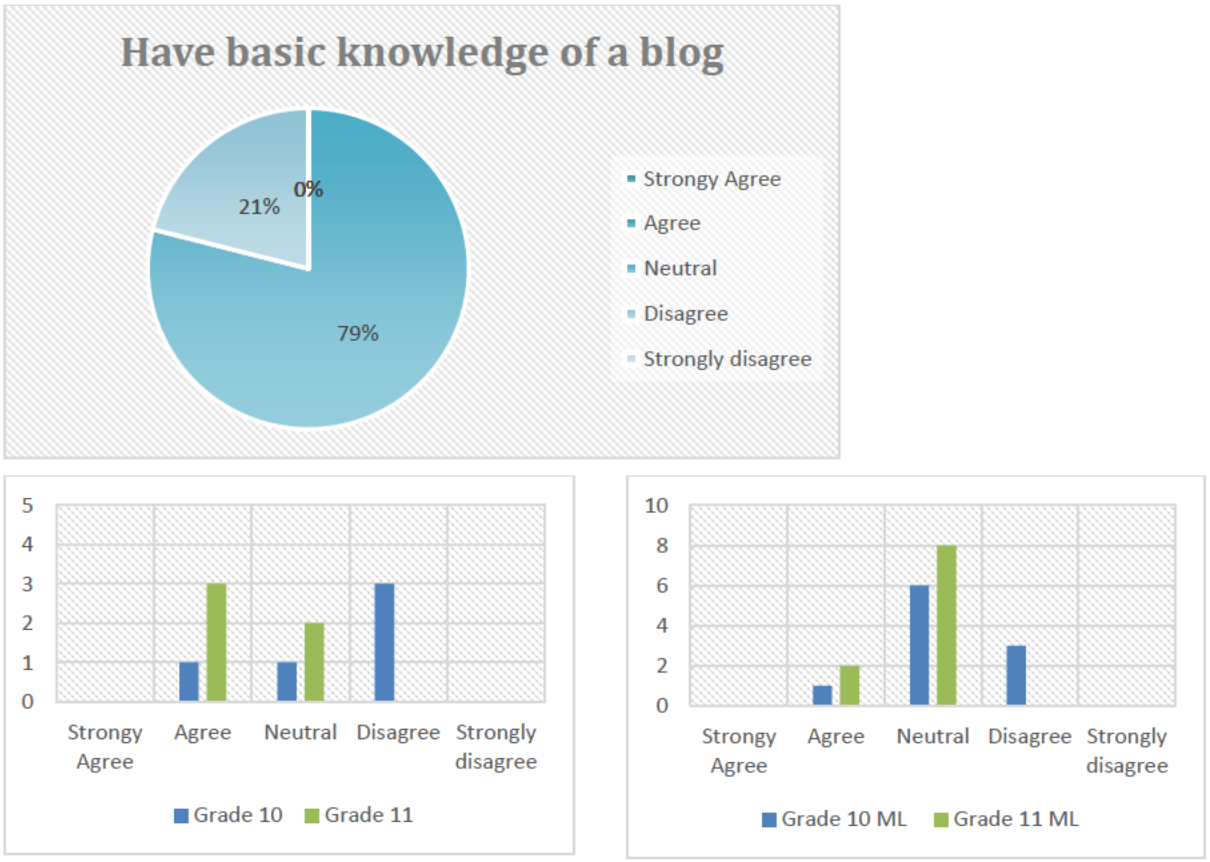


Figure 4.3 Basic knowledge of the blog

Grade 9: Most respondents (79%) demonstrated to be "Neutral" when it comes to their knowledge of the blog. 21% "Disagreed" to have any knowledge of the blog. No respondent from this sample knew about the blog.

Grade 10: The majority (60%) of the five respondents representing the mathematics sample "Disagree" to have used the blog or understand how it works. A single respondent (20%) "Agree" to have used the blog and understands it. The remaining respondents (20%) responded with

"Neutral". Several respondents (30%) within the ML sample confirmed to "Disagree" with having a basic understanding of a blog. However, most respondents were "Neutral", while only one (10%) respondent "Agree" to have visited the blog and had a basic understanding of how it works.

Grade 11: Respondents from the mathematics sample (N=5) "Agree" to have used the blog and fully understood its functionality. However, two (40%) respondents replied with "Neutral". ML respondents had little basic knowledge of the blog, with only two (20%) "Agree". The remaining participants (80%) within this sample were "Neutral".

4.2.1.4 Using a blog to learn mathematics/ mathematical literacy is a good idea.

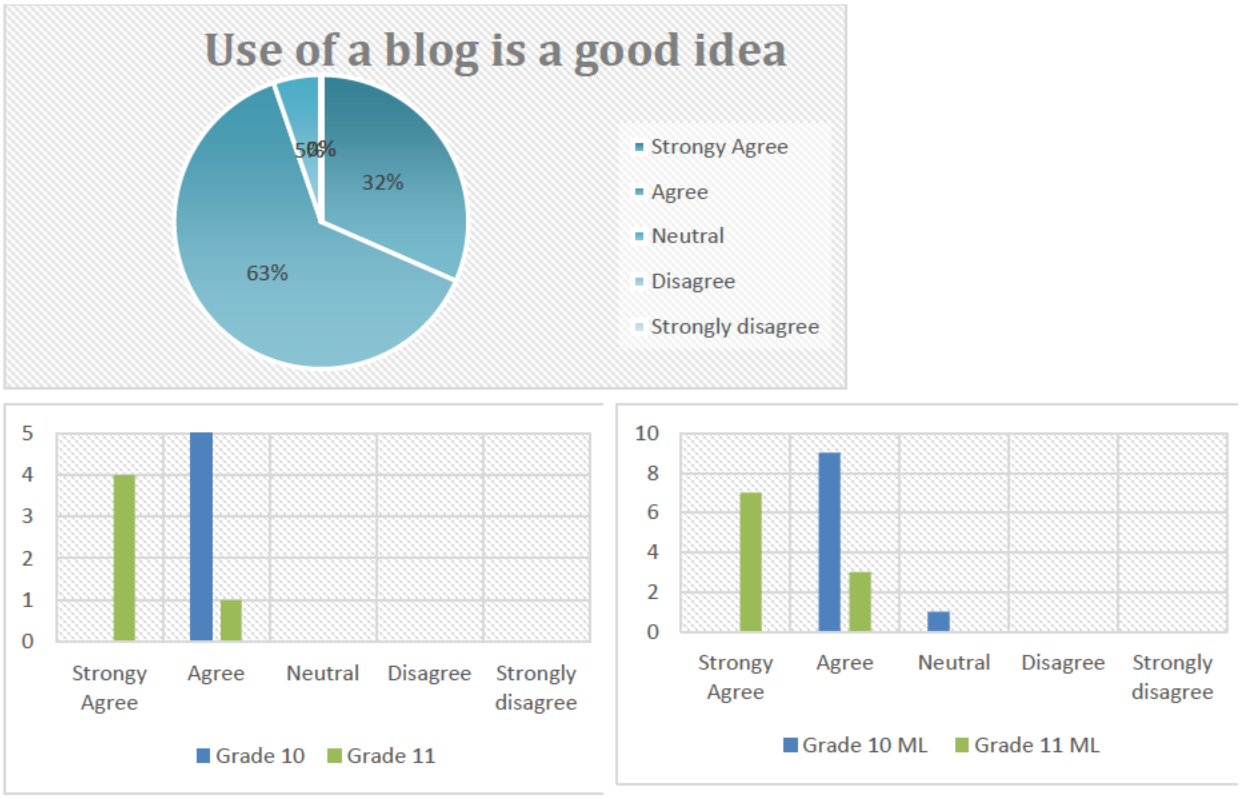


Figure 4.4 Using a blog is a good idea.

Grade 9: The idea of using a blog to learn mathematics seemed to be appealing to the majority of the learners, with 12 respondents (63%) "Agree" that it is a good idea. Two respondents (32%) "Strongly agree", and only one respondent (5%) was "Neutral". No respondent demonstrated to be against the idea of a blog.

Grade 10: Mathematics respondents (N=5) found a blog to be a good idea for their learning. All respondents "Agree" that a blog is a good idea for learning. With ML respondents, one respondent (10%) was either skeptical or not sure about the idea, while the majority (90%) agreed that the idea was good.

Grade 11: Mathematics respondents' results demonstrated that they were in favor of learning through the blog. Three learners (60%) "Strongly Agree", and the other two learners (40%) "Agree". Out of ten respondents that participated in ML, seven (70%) respondents "Strongly Agree" while three respondents (30%) "Agree" that using the blog to learn ML is a good idea.

4.2.1.5 Using a block is beneficial for learning mathematics/mathematical literacy.

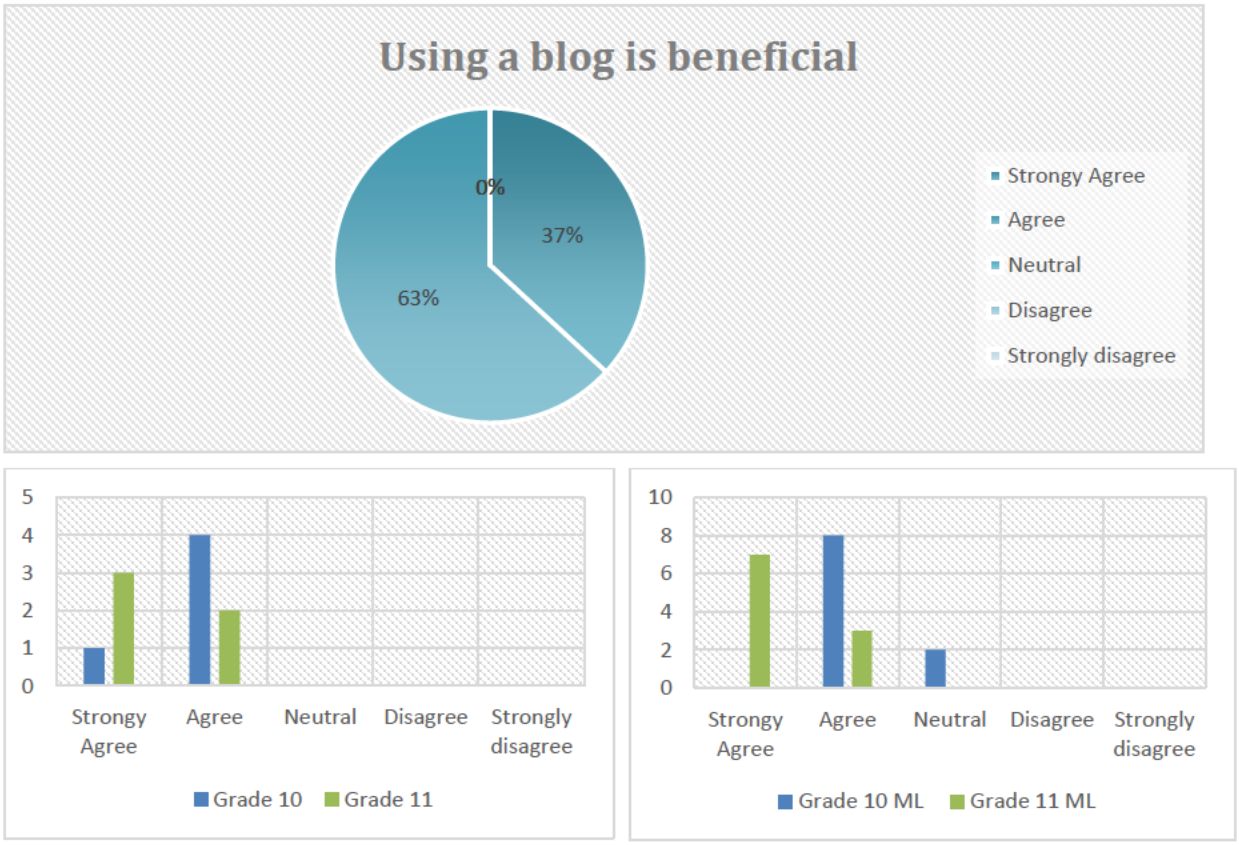


Figure 4.5 The Use of a blog is beneficial.

Grade 09: Respondents displayed different perceptions of using the blog. Seven respondents (37%) agreed strongly with using the blog to learn mathematics. Twelve respondents (63%) "Agree" with the thought of using the blog as beneficial to them.

Grade 10: Mathematics respondents demonstrated to be on board with the idea of a blog. One respondent (20%) "Strongly agree", and the rest of the respondents (80%) in this sample "Agree" that the blog is going to be beneficial for their learning. On the other hand, the ML sample had two respondents (20%) that were "Neutral", and eight respondents (80%) "Agree" that the blog will be beneficial for their learning.

Grade 11: Three mathematics respondents (60%) "Strongly Agree" that the blog will be beneficial for their learning, and two respondents (40%) "Agree" as well. ML participants responded in a much similar trend with their mathematics fellow learners. A large number in the sample (70%) "Strongly agree", and three respondents (30%) "Agree" that they think learning through the blog will be beneficial.

4.2.1.6 Perception about using the blog to learn mathematics/mathematical literacy

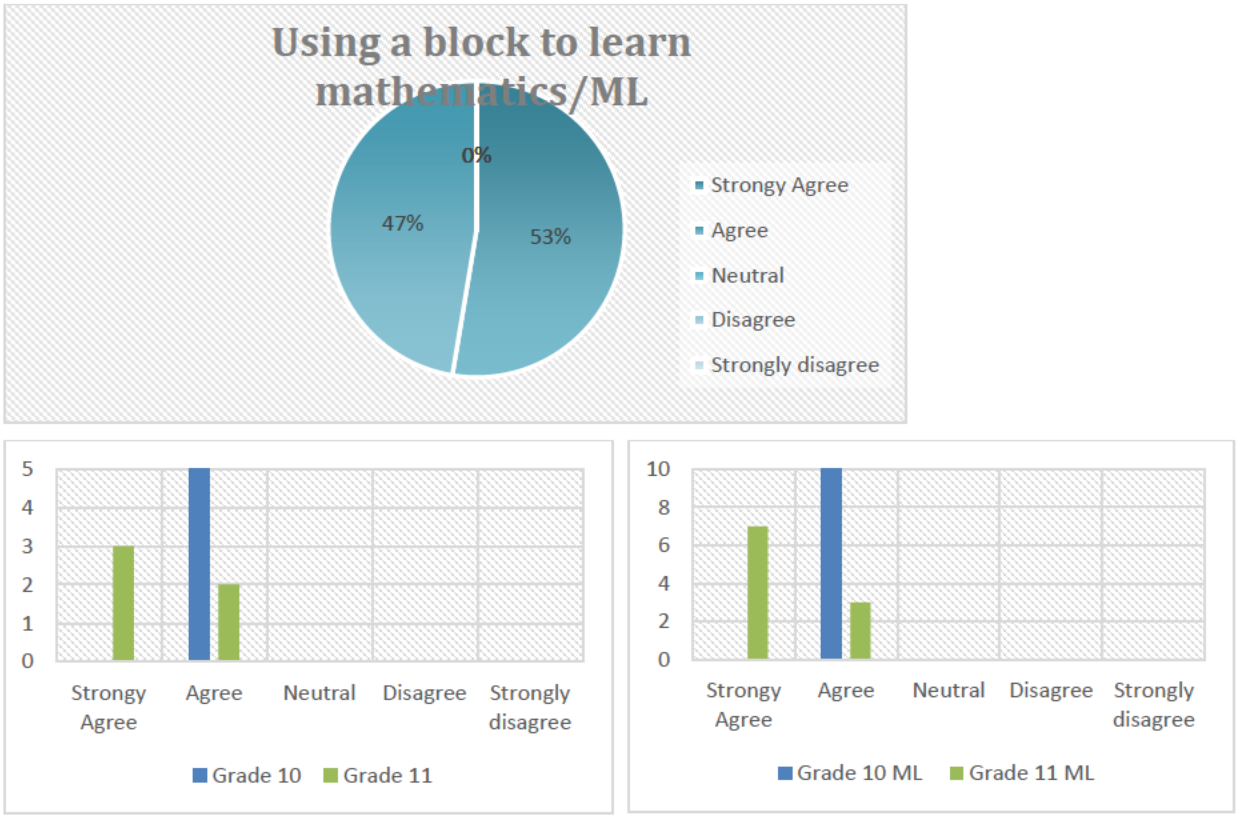


Figure 4.6 Using a blog to learn mathematics/ ML.

Grade 09: Positive perceptions about using the blog were demonstrated by ten respondents (53%) who "Strongly Agree" that the blog might be a new and interesting way of learning. The remaining 47% of respondents also "Agree" that the blog might be the way to learn mathematics better.

Grade 10: All mathematics respondents (N=5) "Agree" to be positive about implementing the blog. ML respondents followed the same trend with all respondents (N=10) that "Agree" to be positive about running the blog to learn ML.

Grade 11: No respondent demonstrated hesitation about the use of the blog. The results show that three (60%) of mathematics respondents "Agree", and two (40%) "Agree". ML participants were also very positive about the idea of a blog. Seven respondents out of ten (70%) "Strongly agree", and three respondents (30%) "Agree".

4.2.2 Phase 1- Open-ended questionnaire (qualitative results)

Learners were required to create a blog using Blogger.com. The objective was to introduce the learners to the concept of blogging, including design and customization. Learners were instructed to post on their blogs and comment on each other's blogs. The practical was a 5-day process. An open-ended questionnaire was handed to the participants after the practical. This questionnaire aimed to get in-depth information about the perceptions after the encounter with a blog. Section A was composed of closed-ended questions, to identify any shift in perceptions resulting from interacting with the blog. However, after a pilot study, some respondents wanted to express why they disagreed with some of the questions in this section. Therefore, all questions were converted to be open-ended to extract more data from the respondents. Section B of the questionnaire focused on extracting detailed information about the experiences the participants came across in designing the blog.

The questions were sampled from a study by Silalahi (2017) and categorized in line with the principles of the connectivism theory. Table 4.1 shows how both questions about perception and experience were categorized

Table 4.1 Experiences and perceptions

Categories	Section A: Perception	Section B: Experience
1. Nodes and Network	I would like to contribute to sharing knowledge with my classmates through blogs.	I'm skilled in linking other blogs to my blog.
2. Dynamic Knowledge	I feel a lot of ideas in my mind to write in the blogs.	I'm skilled in organizing lesson material or assignments in my blog.
3. Technology-Enhanced Learning	I feel that blogs are useful mediums for teaching and learning	I am skilled in posting on my blog
4. Collaborative Learning	I feel the blogs promote collaborative learning	I'm skilled at making polls or other people's comments on my blog
5. Decentralized Learning	I feel confident in deepening the mathematics/ ML lessons provided using blogs.	I'm skilled at creating hyperlinks to websites that can expand my knowledge.

The questionnaire used the Likert-scale questions; a 5-point Likert-scale was used where (1) represent "Strongly Agree", (2) "Agree", (3) "Not Sure", (4) "Disagree", (5) "Strongly disagree"

Table 4.2 Perceptions after training

	Indicator component	Score				
		1	2	3	4	5
	Perception after Training					
I would like to contribute to sharing knowledge with my classmates through blogs.	Grade 09	12	8	2	0	0
	Grade 10 mathematics	4	1	0	0	0
	Grade 10 ML	8	2	0	0	0
	Grade 11 mathematics	4	1	0	0	0
	Grade 11 ML	5	5	0	0	0
I feel a lot of ideas in my mind to write in the blogs.	Grade 09	6	12	2	0	0
	Grade 10 mathematics	2	3	0	0	0
	Grade 10 ML	4	6	0	0	0
	Grade 11 mathematics	3	2	0	0	0
	Grade 11 ML	4	6	0	0	0
I feel that blogs are useful mediums for teaching and learning	Grade 09	12	6	2	0	0
	Grade 10 mathematics	4	1	0	0	0
	Grade 10 ML	7	3	0	0	0
	Grade 11 mathematics	3	2	0	0	0
	Grade 11 ML	6	4	0	0	0
I feel the blogs promote collaborative learning	Grade 09	7	11	0	0	0
	Grade 10 mathematics	3	2	0	0	0
	Grade 10 ML	6	4	0	0	0
	Grade 11 mathematics	4	1	0	0	0
	Grade 11 ML	7	3	0	0	0
I feel confident in deepening the mathematics/ ML lessons provided using blogs.	Grade 09	7	11	0	0	0
	Grade 10 mathematics	3	2	0	0	0
	Grade 10 ML	6	4	0	0	0
	Grade 11 mathematics	4	1	0	0	0
	Grade 11 ML	6	4	0	0	0

The results for all grades are presented in Table 4.2. Respondents demonstrated positive perceptions after creating their blogs. They either strongly agreed or agreed. Some respondents were not sure about some of the questions asked. Two of the Grade 09 respondents were not sure if they would share knowledge with other classmates on the blog

[Grade 09 Respondent 1 of 2] “Some classmates are sharing rude content and pictures on my blog”.

[Grade 09 Respondent 2 of 2] “I know my classmates; they will only expect others to post and copy our posts”.

Not all respondents felt like they had a lot of ideas in their minds to share on the blog.

[Grade 09 Respondent 1 of 2] “I am not sure I will have anything to share. I don’t understand mathematics”.

[Grade 09 Respondent 2 of 2] “I think I will share when I have data because I have to google some other information”.

Other respondents were not sure if the blog was a good medium for teaching and learning.

[Grade 09 Respondent 1 of 2] “I am not sure the blog will be a good medium because sometimes I won’t have data”.

[Grade 09 Respondent 2 of 2] “I am not sure learning through the blog is a good idea, it’s better to have a teacher in front of me”

The data also revealed that some Grade 09 respondents did not respond to all the questions. The last two questions are missing two responses. Table 4.3 provides a summary of data about the experiences of participants after training to create, design, and run the blog. In all five questions, there were no cases where respondents disagreed or disagreed. In cases where the respondents were not sure, it was either they were absent or came late for training.

[Grade 09 Respondents 1] “I am still trying to learn how to link my blog with others because I was absent from school”.

[Grade 10 ML Respondent 1] “I was late for training on the day we were taught to link the blog”.

Similar comments were shared by respondents in questions 2, 3, 4, and 5.

Table 4.3 Experiences after training

	Indicator component	Score				
		1	2	3	4	5
	Ability to Create a Blog					
I'm skilled in linking other blogs to my blog.	Grade 09	7	12	1	0	0
	Grade 10 mathematics	5	0	0	0	0
	Grade 10 ML	9	10	1	0	0
	Grade 11 mathematics	5	0	0	0	0
	Grade 11 ML	10	0	0	0	0
I'm skilled in organizing lesson material or assignments in my blog.	Grade 09	6	13	1	0	0
	Grade 10 mathematics	3	2	0	0	0
	Grade 10 ML	4	5	1	0	0
	Grade 11 mathematics	2	3	0	0	0
	Grade 11 ML	3	6	1	0	0
I am skilled in posting on my blog	Grade 09	4	15	1	0	0
	Grade 10 mathematics	4	1	0	0	0
	Grade 10 ML	2	7	1	0	0
	Grade 11 mathematics	3	2	0	0	0
	Grade 11 ML	5	5	0	0	0
I'm skilled at making polls or other people's comments on my blog	Grade 09	6	13	1	0	0
	Grade 10 mathematics	3	2	0	0	0
	Grade 10 ML	4	5	1	0	0
	Grade 11 mathematics	2	3	0	0	0
	Grade 11 ML	3	6	1	0	0
I'm skilled at creating hyperlinks to websites that can expand my knowledge.	Grade 09	5	13	1	0	0
	Grade 10 mathematics	3	2	0	0	0
	Grade 10 ML	3	6	1	0	0
	Grade 11 mathematics	5	0	0	0	0
	Grade 11 ML	5	5	0	0	0

4.2.3 Focus group interview results

In Phase 1, participants were taught how the blog would be used to learn mathematics and ML. It was a five-day process that involved the creation, customization, and interaction with the blog also known as blogging. Data was collected using both closed-ended and open-ended questionnaires. In phase two the blog is used by the participants to learn mathematics and ML. The focus group interviews were conducted to answer the research question; *what are the key challenges of using the blog?* The data collected was analyzed, and three themes emerged from the data, namely: Technical issues, Real-time connection, and Internet connection and availability.

4.2.3.1 Technical issues

For Turnbull, Chugh, and Luck (2021), technical issues that may confront students in online learning situations are dependent on many factors, such as the quality of communications infrastructure and the availability and access to software and hardware platforms to support learning. One of the fundamental issues that most participants in the study mentioned was the availability of a satisfactory internet connection.

[Grade 09 respondents] “It is not easy to learn about using a blog because if there is no network we cannot learn with other learners”

The same sentiments were shared by some Grade 10 learners:

[Grade 10 mathematics respondents] “Most of us use Cell C, which is very slow in some places”

[Grade 10 ML respondents] “Some of us do get online, but downloading content and following links is time-consuming because of slow internet. We sometimes lose interest in participating”

Grade 11 respondents were also quoted expressing similar challenges:

[Grade 11 mathematics respondents] “We use Cell C and Telkom because it’s cheap, but the network for these service providers is very bad in some of our areas”.

[Grade 11 ML respondents] “When we agree on the time to be online together, some people do not participate and only a few people contribute to the discussions. Others say they are busy, others say they have a slow internet connection, and others are saying they don’t have data”.

There were also issues related to power cuts in areas where the participants reside.

[Grade 09 respondents] “When we have load shedding, the network does not work*”*.

[Grade 10 mathematics respondents] “When there is load shedding, we cannot charge our phone and the network is slow”.

[Grade 10 ML respondents] “Electricity is the problem in most places where we live, and the network does not function if there is no electricity, and we cannot charge our phones”.

[Grade 11 mathematics respondents] “Transformers die all the time because people rob electricity and we can't use phones because we don’t have electricity”.

[Grade 11 ML respondents] “Load shedding makes it difficult for us to collaborate and discuss our home works as a group, we cannot charge our phones, and the network is very slow when there is no electricity”.

Although load shedding is no longer an issue, it was noted by the respondents that power cut issues are still persistent in some communities. As a result, learning with a blog is hindered for learners living in such areas.

4.2.3.2 Real-time connection

In a blended learning situation, communication naturally takes place in both synchronous and asynchronous ways (Turnbull, Chugh, and Luck, 2021). The blog is no exception, it facilitates both ways of learning. The topic the bloggers were discussing remains on the blog and can be accessed at any time if not deleted. This is an example of asynchronous learning. On the other hand, synchronous involves bloggers interacting in real-time, where everyone is online and communication is active. This method of learning is effective when participants are engaging in tasks like homework, studying for an exam, and working on assignments that are due very soon. However, some problems were brought forward by some of the respondents.

[Grade 09 Respondents] “We always find it hard to be online at once, people have different commitments at home, others have no network and others don’t have data”.

[Grade 10 mathematics respondents] “Sometimes we are able to connect, but most of the time it is usually the three of us, some of us have a bad network reception and data to connect to a blog is expensive, it is not like WhatsApp data”.

[Grade 10 ML respondents] “There are too many of us in our group, we never get to be online at the same time, and people do not want to post comments”.

[Grade 11 mathematics respondents] “Others don’t participate. They only come to take our answers, and when we agree on a time, sometimes I’m busy helping with house chores”.

[Grade 11 ML respondents] “Others do not comment to discuss the questions. Only the same people always post and comment”.

Synchronous learning is possible with blogging; however, 100% participation was deemed to be impossible by the respondents. Therefore, both asynchronous and synchronous learning work in combination to achieve learning and accommodate those who cannot engage in real-time learning.

4.2.3.3 Internet connection and affordability

Data tariffs in South Africa are very high, especially for mobile networks. There have been protests including an initiative encapsulated in the hashtag #DataMustFall, which represented the complaint that the prices for mobile broadband access were persistently high and, for many people, unaffordable (Sutherland, 2021). Sutherland (2021) believes that the lack of sufficient competitive pressures has driven the data service operators not to respond to calls from consumers to lower their tariffs. The respondents across all grades in both mathematics and ML shared similar concerns when it comes to data tariffs.

[Grade 09 respondents] “Data is expensive, we sometimes ask our parents and siblings to hotspot us”.

[Grade 10 mathematics respondents]: “We do not have data all the time because it is expensive, Cell C is better but sometimes the network is slow”.

[Grade 10 ML respondents]: “We use public library hotspot data because it is close to some of our homes, data is expensive”.

[Grade 11 mathematics respondents] “It is better to use a router at home because data is expensive, the problem is that not every one of us has a router”.

[Grade 11 ML respondents] “Telkom and Cell C are cheaper than other networks but they are slow, other networks are expensive”

Switching between different service providers, and using WI-FI hotspots were among the solutions that the participants used to combat the challenge of expensive internet data tariffs. Others took advantage of the Wi-Fi provided by the researcher during the day to download files they will use later offline.

4.2.4 Phase 2- Close-ended questionnaire (quantitative results)

This close-ended questionnaire was drafted based on the themes that emerged from the focus group interviews. The aim was to capture quantitative data about the experiences and challenges of the participants during the implementation of Phase 2, which was using the blog to learn mathematics and ML. The data was captured and processed using SPSS. The questionnaire had three sections namely: Technical Issues, Real-time connection, and Cost of using technology.

4.2.4.1 Technical issues

Two questions were asked in this section and the results are presented in tables per grade.

Table 4.4 Network reception availability

Network Reception Availability

Grade 09

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	15	75.0	75.0	75.0
	Sometimes	2	10.0	10.0	85.0
	No	3	15.0	15.0	100.0
	Total	20	100.0	100.0	

Grade 10 Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	80.0	80.0	80.0
	Sometimes	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

Grade 10 ML

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	80.0	80.0	80.0
	Sometimes	2	20.0	20.0	100.0
	Total	10	100.0	100.0	

Grade 11 Maths

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	80.0	80.0	80.0
	Sometimes	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

Grade 11 ML

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	80.0	80.0	80.0
	Sometimes	2	20.0	20.0	100.0
	Total	10	100.0	100.0	

The data above was based on the issue raised by the respondents in terms of network reception. Grade 09 is the only grade with a network issue that contributed significantly to their inability to access the blog, with a portion of 15% recorded. There were cases where respondents mentioned having a loss of network reception *sometimes*. For Grade 9, only 10% experienced a loss of network reception *sometimes* while the other Grades, in mathematics and ML, reported only 20% network reception loss *sometimes.*

Table 4.5 Signal/Network Strength

Signal/ Network Strength

Grade 09

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strong	8	40.0	40.0	40.0
	Moderate	9	45.0	45.0	85.0
	Weak	3	15.0	15.0	100.0
	Total	20	100.0	100.0	

Grade 10 Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strong	1	20.0	20.0	20.0
	Moderate	3	60.0	60.0	80.0
	Weak	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

Grade 10 ML

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strong	1	10.0	10.0	10.0
	Moderate	7	70.0	70.0	80.0
	Weak	2	20.0	20.0	100.0
	Total	10	100.0	100.0	

Grade 11 Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strong	1	20.0	20.0	20.0
	Moderate	3	60.0	60.0	80.0
	Weak	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

Gade 11 ML

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strong	2	20.0	20.0	20.0
	Moderate	7	70.0	70.0	90.0
	Weak	1	10.0	10.0	100.0
	Total	10	100.0	100.0	

Signal strength plays a crucial role in blogging, a weak signal strength can cause learners to lose interest in using the blog. The moderate signal is not bad since the files that learners share on the blog are not large, they can easily be downloaded and shared even if the network is not at its best. The data from the respondents revealed that the majority of respondents from each grade had a moderate signal. However, 15% of respondents from Grade 9 had a weak signal, with 20% across Grade 10 Mathematics and ML. Grade 11 Mathematics had 20% of respondents, and ML had 10%, which had a weak network signal.

4.2.4.2 Real-time connection

This section was broken down into three questions to understand the involvement of participants in blogging activities.

Table 4.6 Real-time access

Real-time Access

Grade 09

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	45.0	45.0	45.0
	Sometimes	7	35.0	35.0	80.0
	No	4	20.0	20.0	100.0
	Total	20	100.0	100.0	

Grade 10 Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	60.0	60.0	60.0
	Sometimes	1	20.0	20.0	80.0
	No	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

Grade 10 ML

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	40.0	40.0	40.0
	Sometimes	4	40.0	40.0	80.0
	No	2	20.0	20.0	100.0
	Total	10	100.0	100.0	

Grade 11 Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	60.0	60.0	60.0
	Sometimes	2	40.0	40.0	100.0
	Total	5	100.0	100.0	

Grade 11 ML

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	70.0	70.0	70.0
	Sometimes	3	30.0	30.0	100.0
	Total	10	100.0	100.0	

Blogging can be both synchronous and asynchronous. Being synchronous means bloggers can interact back-to-back live. The data from the respondents revealed that the majority of bloggers were able to interact with each other to learn live. For Grade 9, 45% confirmed to have had real-time conversations with other bloggers. Grade 10 and Grade 11 Mathematics had 60% of bloggers who can be live simultaneously, while Grade 10 and Grade 11 ML had 40% and 70%, respectively. However, Grade 09, Grade 10 Mathematics, and Grade 11 ML had a few cases where participants could not interact with other bloggers in real-time with 20% each.

Table 4.7 Real-time participation

Real-Time Participation

Grade 09

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	45.0	45.0	45.0
	Moderate	6	30.0	30.0	75.0
	No	5	25.0	25.0	100.0
	Total	20	100.0	100.0	

Grade 10 Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	60.0	60.0	60.0
	Moderate	1	20.0	20.0	80.0
	No	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

Grade 10 ML

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	5	50.0	50.0	50.0
	Moderate	4	40.0	40.0	90.0
	No	1	10.0	10.0	100.0
	Total	10	100.0	100.0	

Grade 11 Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	40.0	40.0	40.0
	Moderate	3	60.0	60.0	100.0
	Total	5	100.0	100.0	

Grade 11 ML

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6	60.0	60.0	60.0
	Moderate	3	30.0	30.0	90.0
	No	1	10.0	10.0	100.0
	Total	10	100.0	100.0	

Being part an online group at the same time is not enough, blogging involves input from the blogger. They must be able to comment and be part of the topic discussed at that moment. For each grade, some bloggers were active, others 'level of participation was moderate, and there were those who did not engage in such activities. Grade 11 mathematics was the only grade with respondents that participated less in live discussions with only 40%, and the most being moderate. Other grades demonstrated a higher percentage of online participation, though there were cases of moderate level of participation and fewer cases of zero participation per grade.

Table 4.8 Missed group discussion follow-up

Missed Group Discussions Follow-Up

Grade 09

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	12	60.0	60.0	60.0
	Sometimes	6	30.0	30.0	90.0
	No	2	10.0	10.0	100.0
	Total	20	100.0	100.0	

Grade 10 Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	60.0	60.0	60.0
	Sometimes	2	40.0	40.0	100.0
	Total	5	100.0	100.0	

Grade 10 ML

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	70.0	70.0	70.0
	Sometimes	3	30.0	30.0	100.0
	Total	10	100.0	100.0	

Grade 11 Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	80.0	80.0	80.0
	Sometimes	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

Grade 11 ML

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	80.0	80.0	80.0
	Sometimes	2	20.0	20.0	100.0
	Total	10	100.0	100.0	

The blog also allows asynchronous communication where respondents who missed the live discussions can catch up on what was discussed. The data revealed that there were 10% (N=2) of respondents in Grade 09 that were not able to do a follow-up on the live discussions that they missed. Other grades had few cases where respondents did follow-ups sometimes. The data also revealed that the majority of respondents from each grade did a follow-up when they missed the live discussions. Grade 11 mathematics and ML had the highest follow-up rate of 80% each, followed by Grade 10 ML with a 70% follow-up rate. Lastly, Grade 9 and Grade 10 mathematics with a 60% rate each.

4.2.4.2 Internet connection and affordability

Internet connection and affordability are the engines of blogging. Without these resources learning through the blog is impossible. The last section of the questionnaire involved finding data about the participants' internet connection and affordability.

Table 4.9 Preferred connection method

Preferred connection method

Grade 09

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Cellular Data	8	40.0	40.0	40.0
	Wi-Fi	12	60.0	60.0	100.0
	Total	20	100.0	100.0	

Grade 10 Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Cellular Data	1	20.0	20.0	20.0
	Wi-Fi	4	80.0	80.0	100.0
	Total	5	100.0	100.0	

Grade 10 ML

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Cellular Data	6	60.0	60.0	60.0
	Wi-Fi	4	40.0	40.0	100.0
	Total	10	100.0	100.0	

Grade 11 Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Cellular Data	2	40.0	40.0	40.0
	Wi-Fi	3	60.0	60.0	100.0
	Total	5	100.0	100.0	

Grade 11 ML

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Cellular Data	5	50.0	50.0	50.0
	Wi-Fi	5	50.0	50.0	100.0
	Total	10	100.0	100.0	

On average Wi-Fi was the most used method of connection. With 60% in Grade 09 and Grade 11 mathematics, 80% in Grade 10 mathematics, 40% in Grade 10 ML, and 50% in Grade 11 ML.

Table 4.10 Network Service Providers

Network Service Providers

Grade 09

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MTN	2	10.0	10.0	10.0
	Vodacom	1	5.0	5.0	15.0
	Cell C	9	45.0	45.0	60.0
	Telkom	8	40.0	40.0	100.0
	Total	20	100.0	100.0	

Grade 10 Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Vodacom	1	20.0	20.0	20.0
	Cell C	3	60.0	60.0	80.0
	Telkom	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

Grade 10 ML

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MTN	1	10.0	10.0	10.0
	Cell C	6	60.0	60.0	70.0
	Telkom	3	30.0	30.0	100.0
	Total	10	100.0	100.0	

Grade 11 Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Cell C	3	60.0	60.0	60.0
	Telkom	2	40.0	40.0	100.0
	Total	5	100.0	100.0	

Grade 11 ML

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MTN	1	10.0	10.0	10.0
	Cell C	6	60.0	60.0	70.0
	Telkom	3	30.0	30.0	100.0
	Total	10	100.0	100.0	

Participants chose their service providers based on the tariffs and network coverage in the area. From the data provided by the respondents, Cell C was the most preferred network across all grades with Telkom taking the second place. Respondents were given a choice of 4 networks from the questionnaire, and a choice to add "others" that were not mentioned on the list. MTN and Vodacom were included on the list. However, fewer respondents subscribed to these networks.

Table 4.11 Internet data affordability

Internet Data Affordability

Grade 09

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6	30.0	30.0	30.0
	Sometimes	8	40.0	40.0	70.0
	No	6	30.0	30.0	100.0
	Total	20	100.0	100.0	

Grade 10 Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1	20.0	20.0	20.0
	Sometimes	2	40.0	40.0	60.0
	No	2	40.0	40.0	100.0
	Total	5	100.0	100.0	

Grade 10 ML

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1	10.0	10.0	10.0
	Sometimes	5	50.0	50.0	60.0
	No	4	40.0	40.0	100.0
	Total	10	100.0	100.0	

Grade 11 Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1	20.0	20.0	20.0
	Sometimes	4	80.0	80.0	100.0
	Total	5	100.0	100.0	

Grade 11 ML

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	20.0	20.0	20.0
	Sometimes	6	60.0	60.0	80.0
	No	2	20.0	20.0	100.0
	Total	10	100.0	100.0	

Only a few percent of respondents were confident that they could afford cellular data, which justifies the choice of having more Wi-Fi users. Grade 10 ML had the lowest number of respondents at 10%. Grade 10 mathematics, Grade 11 mathematics and Grade 11 ML had 20%, respectively. Lastly, in Grade 09, only 30% of respondents could afford buying data. In other cases, respondents could afford the data sometimes, not all the time.

4.2.5 Secondary and primary data results

According to Ajayi (2017), the fundamental differences between primary and secondary data are that the term primary data refers to the data originated by the researcher for the first time, while secondary data is the already existing data collected by the investigator agencies and organizations earlier. Below, secondary data from SASAMS (the school assessment database) is represented to give a baseline view of how all learners in Grade 09, Grade 10, and Grade 11 are performing in Mathematics and ML, before the blog and after the blog. The data represents the whole population per grade, and the aim is to identify if there is any change in performance.

SPSS was used to demonstrate the data in the form of a box and whisker plot also known as a five-number summary. The boxplot provides a quick visual summary of the considered data set. Location (through median and quartiles), spread (using the interquartile range), shape (position of the median in the box), and possible outliers (values beyond the fences) are simultaneously observed with the boxplot (Morales, Giraldo, and Torres, 2021)

4.2.5.1 Marks before the blog and after the blog for all learners

Grade 9 Mathematics

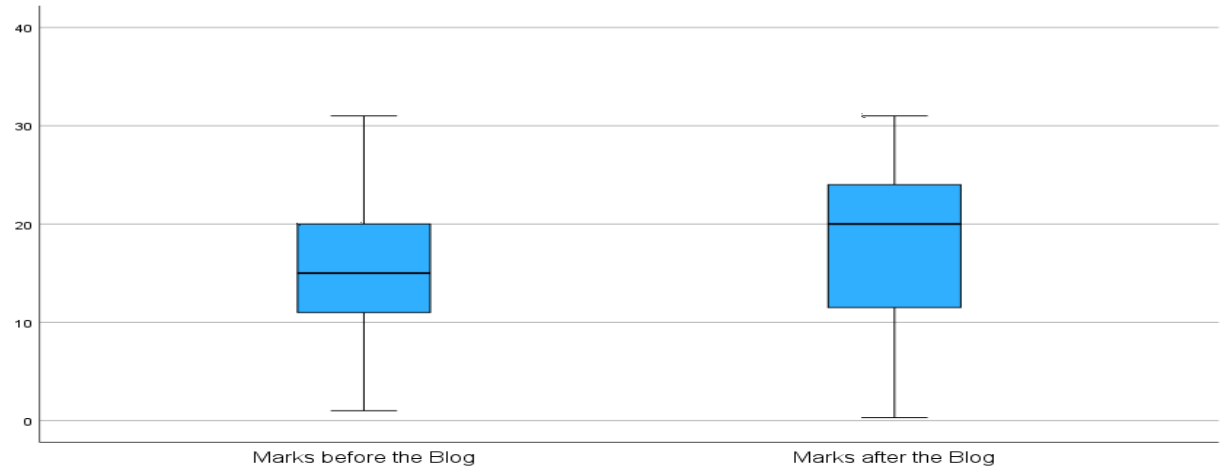


Figure 4.7 Grade 09 Marks before and after the blog

The marks before the blog are results from the September controlled test, which has a total mark of 50, and the marks after the blog represent November results out of 50. Before the blog, the minimum and maximum marks for all learners were 1 and 31, respectively. 75% of learners had a class mark of 20 and below out of the total of 50. After the blog, the maximum mark was 31 out of 50, and the minimum was 0. However, there was improvement with, 75% of learners getting marks between 0 and 24.

Grade 10 Mathematics

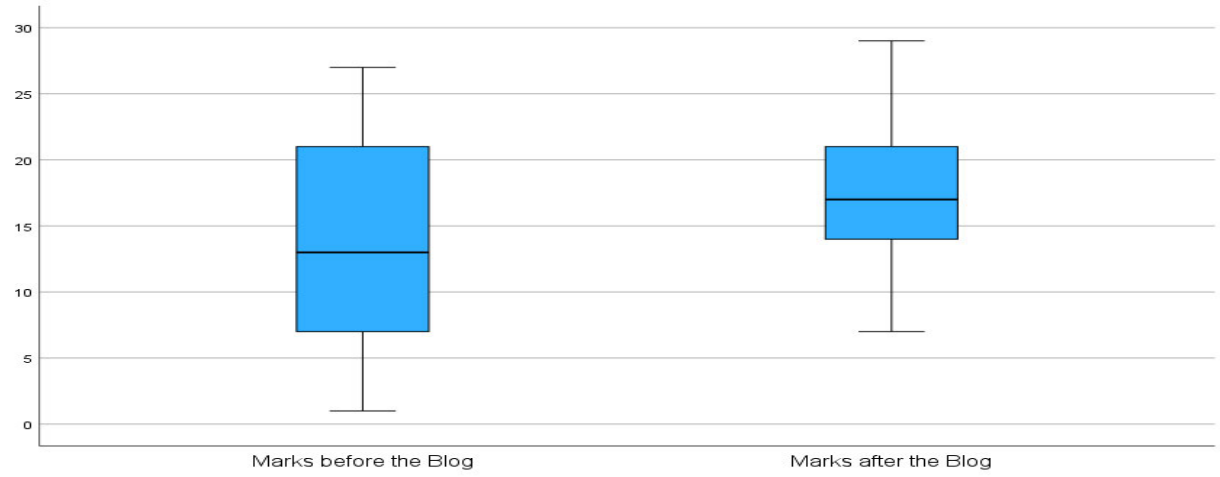


Figure 4.8 Grade 10 mathematics marks before and after the blog

Before the blog, learners had a minimum of 7 out of 50 marks and a maximum of 27, and the majority of the learners in the interquartile range got marks between 7 and 22 out of 50. After the blog, the minimum mark learners could get was 7, and the maximum was 29. 50% of the learners got a mark of between 17 and 29.

Grade 10 ML

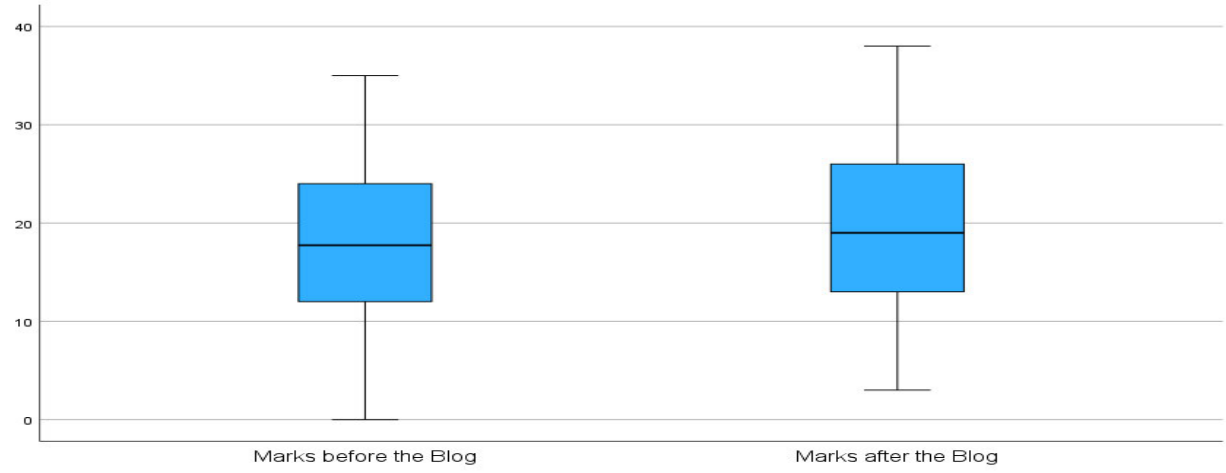


Figure 4.9 Grade 10 ML marks before and after the blog

An alarming minimum of 0 and a maximum of 35 of 50 were the marks recorded for grade 10 ML before the blog. Half of the learners were able to get the marks between the average of 17, 74 and the maximum of 35. The minimum marks recorded after the blog was three and a maximum of 38 marks out of 50. Only 25% of learners were able to get the marks between 26 and a maximum of 38 out of 50.

Grade 11 Mathematics

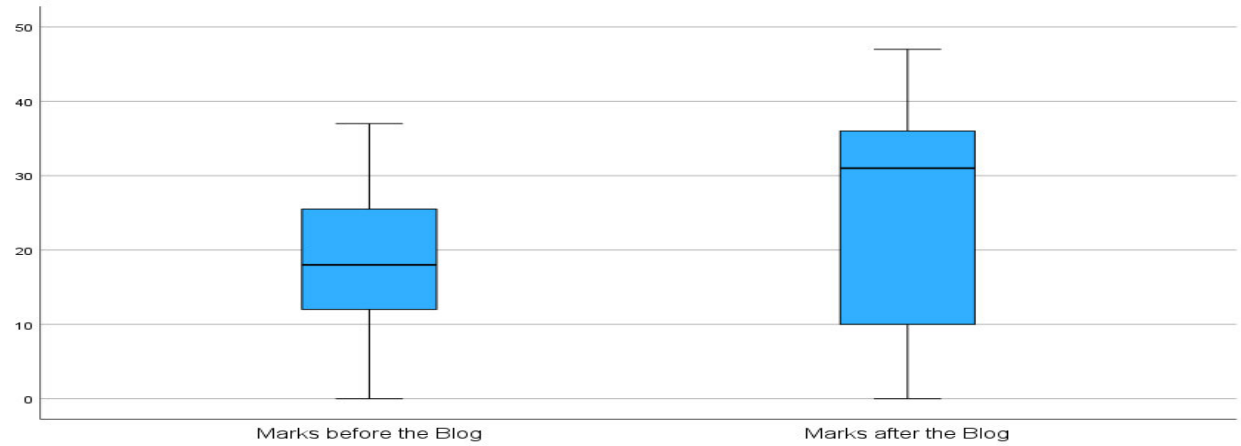


Figure 4.10 Grade 11 mathematics marks before and after the blog

The total marks for the Grade 11 examination were out of 75, and the maximum recorded before the blog was 37 with a minimum of 0. 75% of learners were not able to get marks above 26 out of 75. However, after the blog, half of the learners were able to get the marks between 0 and an average of 35 out of 75. 25% of the learners managed to get marks between an average of 36 and a maximum of 47.

Grade 11 ML

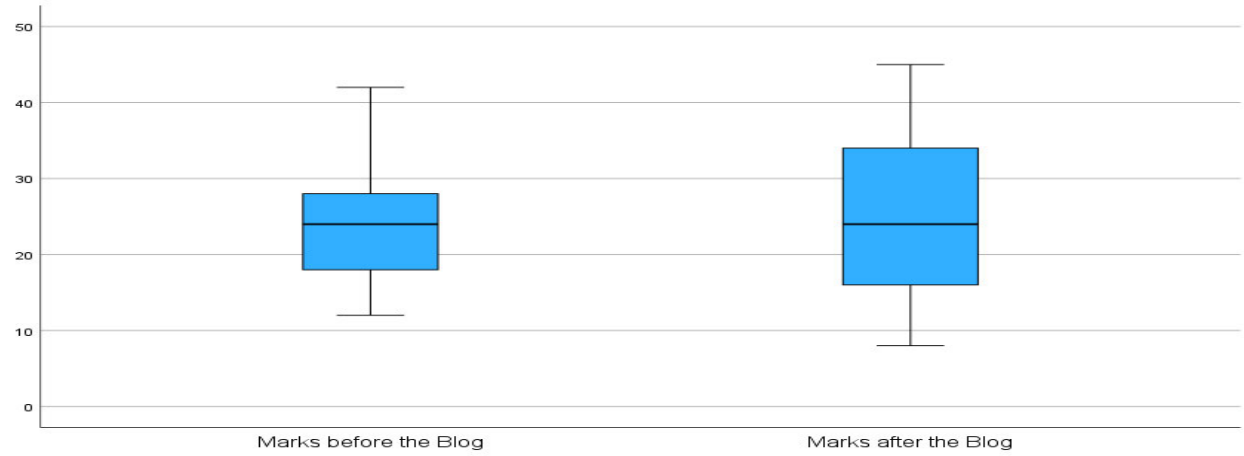


Figure 4.11 Garde11 ML marks before and after the blog

Before the blog, a minimum of 12 and a maximum of 42 was recorded. However, an alarming 75% of learners could not get a mark above an average of 28.5 out of 75. After the blog, a decrease in a minimum mark from 12 to 8, and an increase of a maximum mark from 42 to 45 was recorded. 75% of learners were able reach an average of 34.25 and below.

4.2.5.2 Marks before and after the blog for participants

Before the comparison of marks of learners that were chosen to participate in the study, a normality test of data was done. The normality test aimed to assist in selecting a suitable comparison tool for the data. For normality distribution, parametric tests are used, and for data that is not normally distributed non-parametric tests are used. Table 4.3 displays the results of normality.

Table 4.12 Normality tests

Normality Tests

Grade 09 Mathematics

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Marks Before the Blog	.135	20	.200*	.965	20	.647
Marks After the Blog	.204	20	.029	.930	20	.157

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Grade 10 Mathematics

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Marks Before the Blog	.290	5	.195	.771	5	.046
Marks After the Blog	.235	5	.200*	.872	5	.277

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Grade 10 ML

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Marks_before_Blog	.112	10	.200*	.976	10	.942
Marks_after_blog	.191	10	.200*	.887	10	.159

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Grade 11 Mathematics

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Marks before the Blog	.261	5	.200*	.823	5	.124
Marks after the Blog	.159	5	.200*	.977	5	.918

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Grade 11 ML

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Marks Before the Blog	.252	10	.073	.896	10	.199
Marks After the Blog	.160	10	.200*	.932	10	.471

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

The Shapiro-Wilk test was used for the normality test because of the size of the data which was less than 200 participants. In the table above, if the P-value (Sig.) is greater than 0.05, then the data will normally be distributed. The data across all grades was normally distributed, except for Grade 10 mathematics marks before using the blog.

A One-Way ANOVA test was conducted to test if there was any change in the marks of learners who used the blog. According to Demir (2022), Parametric methods in data analysis (t-tests, ANOVA, etc.) are used in cases where the data obtained from the sample have a normal distribution. The test was done on respondents that had (a) real-time access to the blog, (b) participated in the real-time discussions, and (c) a follow-up after missing the real-time participation.

Table 4.13 Marks analysis for respondents that had real-time access to the blog

Grade 09 Mathematics

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Marks Before the Blog	Yes	9	14.44	3.206	1.069	11.98	16.91	9	20
	Sometimes	7	16.00	5.164	1.952	11.22	20.78	7	22
	No	4	23.75	5.679	2.839	14.71	32.79	18	30
	Total	20	16.85	5.556	1.242	14.25	19.45	7	30
Marks After the Blog	Yes	9	20.78	3.563	1.188	18.04	23.52	13	25
	Sometimes	7	20.86	7.426	2.807	13.99	27.72	7	28
	No	4	16.50	5.066	2.533	8.44	24.56	12	23
	Total	20	19.95	5.472	1.224	17.39	22.51	7	28

Grade 10 Mathematics

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Marks Before the Blog	Yes	3	13.67	9.452	5.457	-9.81	37.15	3	21
	Sometimes	1	23.00	.	.	.	.	23	23
	No	1	22.00	.	.	.	.	22	22
	Total	5	17.20	8.258	3.693	6.95	27.45	3	23
Marks After the Blog	Yes	3	20.00	4.583	2.646	8.62	31.38	16	25
	Sometimes	1	29.00	.	.	.	.	29	29
	No	1	16.00	.	.	.	.	16	16
	Total	5	21.00	5.788	2.588	13.81	28.19	16	29

Grade 10 ML

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Marks Before the Blog	Yes	4	21.75	7.932	3.966	9.13	34.37	12	31
	Sometimes	4	17.50	4.655	2.327	10.09	24.91	11	22
	No	2	21.50	6.364	4.500	-35.68	78.68	17	26
	Total	10	20.00	6.110	1.932	15.63	24.37	11	31
Marks After the Blog	Yes	4	24.25	4.349	2.175	17.33	31.17	18	28
	Sometimes	4	18.50	6.807	3.403	7.67	29.33	13	27
	No	2	14.00	2.828	2.000	-11.41	39.41	12	16
	Total	10	19.90	6.297	1.991	15.40	24.40	12	28

Grade 11 Mathematics

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Marks before the Blog	Yes	3	20.00	7.211	4.163	2.09	37.91	12	26
	Sometimes	2	18.00	8.485	6.000	-58.24	94.24	12	24
	Total	5	19.20	6.723	3.007	10.85	27.55	12	26
Marks after the Blog	Yes	3	36.00	11.000	6.351	8.67	63.33	25	47
	Sometimes	2	10.00	5.657	4.000	-40.82	60.82	6	14
	Total	5	25.60	16.471	7.366	5.15	46.05	6	47

Grade 11 ML

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Marks Before the Blog	Yes	7	19.29	2.984	1.128	16.53	22.05	16	23
	Sometimes	3	21.67	2.517	1.453	15.42	27.92	19	24
	Total	10	20.00	2.944	.931	17.89	22.11	16	24
Marks After the Blog	Yes	7	34.29	9.160	3.462	25.81	42.76	23	45
	Sometimes	3	11.67	4.726	2.728	-.07	23.41	8	17
	Total	10	27.50	13.427	4.246	17.90	37.10	8	45

The average (mean) and standard deviation are considered to be a good measurement for data that is normally distributed. The mean for respondents who had access to real-time blogging increased across all grades. While those that had access sometimes show an increase for Grade 10 mathematics and ML, and a decrease for Grades 9 and 11. Grades 09 and 10 had some respondents who did not access real-time blogging, and they experienced a decrease on average after using the blog.

Table 4.14 Marks analysis for respondents who participated in real-time discussions

Grade 09 Mathematics

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Marks Before the Blog	Yes	9	16.67	2.550	.850	14.71	18.63	14	20
	Sometimes	6	13.33	5.465	2.231	7.60	19.07	7	22
	No	5	21.40	7.197	3.219	12.46	30.34	12	30
	Total	20	16.85	5.556	1.242	14.25	19.45	7	30
Marks After the Blog	Yes	9	23.11	2.977	.992	20.82	25.40	20	28
	Sometimes	6	18.33	6.976	2.848	11.01	25.65	7	25
	No	5	16.20	4.438	1.985	10.69	21.71	12	23
	Total	20	19.95	5.472	1.224	17.39	22.51	7	28

Grade 10 Mathematics

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Marks Before the Blog	Yes	3	14.33	10.263	5.925	-11.16	39.83	3	23
	Moderate	1	21.00	.	.	.	.	21	21
	No	1	22.00	.	.	.	.	22	22
	Total	5	17.20	8.258	3.693	6.95	27.45	3	23
Marks After the Blog	Yes	3	21.33	6.807	3.930	4.42	38.24	16	29
	Moderate	1	25.00	.	.	.	.	25	25
	No	1	16.00	.	.	.	.	16	16
	Total	5	21.00	5.788	2.588	13.81	28.19	16	29

Grade 10 ML

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Marks Before the Blog	Yes	5	19.20	4.970	2.223	13.03	25.37	11	24
	Sometimes	4	19.50	8.103	4.052	6.61	32.39	12	31
	No	1	26.00	.	.	.	.	26	26
	Total	10	20.00	6.110	1.932	15.63	24.37	11	31
Marks After the Blog	Yes	5	22.80	6.099	2.728	15.23	30.37	13	28
	Sometimes	4	18.25	5.560	2.780	9.40	27.10	13	26
	No	1	12.00	.	.	.	.	12	12
	Total	10	19.90	6.297	1.991	15.40	24.40	12	28

Grade 11 Mathematics

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Marks before the Blog	Yes	2	24.00	2.828	2.000	-1.41	49.41	22	26
	Sometimes	3	16.00	6.928	4.000	-1.21	33.21	12	24
	Total	5	19.20	6.723	3.007	10.85	27.55	12	26
Marks after the Blog	Yes	2	36.00	15.556	11.000	-103.77	175.77	25	47
	Sometimes	3	18.67	15.535	8.969	-19.92	57.26	6	36
	Total	5	25.60	16.471	7.366	5.15	46.05	6	47

Grade 11 ML

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Marks Before the Blog	Yes	6	19.50	3.209	1.310	16.13	22.87	16	23
	Sometimes	3	20.33	3.215	1.856	12.35	28.32	18	24
	No	1	22.00	.	.	.	.	22	22
	Total	10	20.00	2.944	.931	17.89	22.11	16	24
Marks After the Blog	Yes	6	36.17	8.424	3.439	27.33	45.01	24	45
	Sometimes	3	16.00	7.550	4.359	-2.75	34.75	8	23
	No	1	10.00	.	.	.	.	10	10
	Total	10	27.50	13.427	4.246	17.90	37.10	8	45

The second test was based on establishing whether participating in a real-time discussion had an impact on the average performance of learners. The data confirmed an increase in average after using the blog across all grades for those who participated in real-time discussions. In the case of those that participated sometimes; Grade 09 had an increase on average after using the blog, Grade 10 had an increase on average for the mathematics group and a decrease on average for the ML group, and Grade 11 experienced an increase on average for mathematics and a decrease on average for ML. All the grades with respondents who did not participate in real-time blogging experienced a decline in average marks after using the blog.

Table 4.15 Marks for respondents who make a follow-up after missing real-time discussions

Grade 09 Mathematics

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Marks Before the Blog	Yes	12	14.75	3.279	.946	12.67	16.83	9	20
	Sometimes	6	18.67	6.653	2.716	11.68	25.65	7	27
	No	2	24.00	8.485	6.000	-52.24	100.24	18	30
	Total	20	16.85	5.556	1.242	14.25	19.45	7	30
Marks After the Blog	Yes	12	21.33	4.376	1.263	18.55	24.11	13	28
	Sometimes	6	18.83	7.223	2.949	11.25	26.41	7	25
	No	2	15.00	4.243	3.000	-23.12	53.12	12	18
	Total	20	19.95	5.472	1.224	17.39	22.51	7	28

Grade 10 Mathematics

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Marks Before the Blog	Yes	3	16.00	11.269	6.506	-11.99	43.99	3	23
	Sometimes	2	19.00	2.828	2.000	-6.41	44.41	17	21
	Total	5	17.20	8.258	3.693	6.95	27.45	3	23
Marks After the Blog	Yes	3	21.33	6.807	3.930	4.42	38.24	16	29
	Sometimes	2	20.50	6.364	4.500	-36.68	77.68	16	25
	Total	5	21.00	5.788	2.588	13.81	28.19	16	29

Grade 10 ML

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Marks Before the Blog	Yes	7	18.00	4.865	1.839	13.50	22.50	11	24
	Sometimes	3	24.67	7.095	4.096	7.04	42.29	17	31
	Total	10	20.00	6.110	1.932	15.63	24.37	11	31
Marks After the Blog	Yes	7	20.71	6.291	2.378	14.90	26.53	13	28
	Sometimes	3	18.00	7.211	4.163	.09	35.91	12	26
	Total	10	19.90	6.297	1.991	15.40	24.40	12	28

Grade 11 Mathematics

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Marks before the Blog	Yes	4	21.00	6.218	3.109	11.11	30.89	12	26
	Sometimes	1	12.00	.	.	.	.	12	12
	Total	5	19.20	6.723	3.007	10.85	27.55	12	26
Marks after the Blog	Yes	4	30.50	14.201	7.100	7.90	53.10	14	47
	Sometimes	1	6.00	.	.	.	.	6	6
	Total	5	25.60	16.471	7.366	5.15	46.05	6	47

Grade 11 ML

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Marks Before the Blog	Yes	8	19.25	2.765	.977	16.94	21.56	16	23
	Sometimes	2	23.00	1.414	1.000	10.29	35.71	22	24
	Total	10	20.00	2.944	.931	17.89	22.11	16	24
Marks After the Blog	Yes	8	31.00	12.581	4.448	20.48	41.52	8	45
	Sometimes	2	13.50	4.950	3.500	-30.97	57.97	10	17
	Total	10	27.50	13.427	4.246	17.90	37.10	8	45

A blog is both synchronous and asynchronous, which means participants who missed the real-time discussions can tap into some old discussions for follow-up. The last comparison's objective was to establish if there was any change in average for those who missed real-time

discussions and did a follow-up later. After using a blog, doing a follow-up yielded an increment in average marks across all grades. Grade 09 is the only grade that had respondents who did not do a follow-up, and they demonstrated a decrease in average marks after using the blog. Furthermore, respondents who did a follow-up sometimes had a decrease in average marks after using the blog, except for Grade 10 mathematics.

4.3 Summary of the chapter

Two phases of action research were carried out in this study, employing mixed-method evaluation design methods to collect data. Phase 1 involved training the participants on how to use the blog. Before the training, quantitative data was collected to get ICT background information about the participants and their perceptions of the blog. At the end of the training, an open-ended questionnaire was handed over to get descriptive information about the learners' perceptions and experiences after interacting and understanding the blog better and if there were any challenges. As part of action research, it was important to analyze and understand this information as it forms the basis for moving to the next phase. The finding revealed that the cellular phone is the most commonly used gadget across all grades. Cellular data, Wi-Fi, and hotspots from a family member were the most used methods of connection. The majority of participants were familiar with the internet and social media. Most participants were positive about the use of the blog, and there were few cases where respondents were neutral. Participants were also positive about using the blog to learn mathematics and ML. Qualitative findings of Phase 1 were analyzed according to preexisting themes extracted from the connectivism learning theory. Social learning, continuous learning, digital literacy, diverse perspectives, and open educational resources were the themes on which the theme analysis was based. Participants raised concerns about real-time learning that was not possible for some of them because of various reasons. Nonetheless, participants were positive about learning through blogs. They also share positive experiences after learning how to blog. Phase 2 began with participants using the blog to learn mathematics and ML. A focus group meeting was used to understand the challenges that participants encountered during the learning process over the bog. The data was broken down into three themes; Technical issues, Real-time Connection, and Internet availability and affordability. These themes were used to construct the close-ended questionnaire that was used at the end of Phase 2 to capture quantitative data about

the experiences and challenges participants came across. Furthermore, baseline data of how all learners perform was extracted from the school database, to compare all the learners before and after the blog. The data revealed some improvement on average. Finally, a One-Way ANOVA test was conducted to compare the results before and after the blog for participants who had real-time access to the blog, participated in real-time discussions, and did a follow-up of discussions missed. The data revealed an increment on average, and a decrease on average for those who did not have access, did not participate, and did not do a follow-up.

5. CHAPTER 5: ANALYSIS OF RESULTS

5.1 Introduction

Chapter Four presents the results in graphs, tables, pre-existing themes, themes that emerged from the data, and secondary and primary data analysis. The data was collected to answer the research questions mentioned in Chapter One. This chapter will further discuss the results in line with the theoretical framework, literature, themes, and research objectives. The objective of this study was to explore whether the use of the blog can improve the results of grades 9 to 11 for mathematics and ML, and to explore the learners' perceptions and experiences towards using the blog. In doing so, three research questions had to be answered by the study;

- What are the learners' perceptions and experiences towards using the blog?
- What are the key challenges of using the blog?
- Can using a blog in mathematics and ML help improve learner results?

Following the action research design, two questionnaires were given to participants before and after the first phase of action research to get data about the perceptions and experiences of using the blog. The second phase involved running the blog, and focus group interviews were conducted to obtain data about the key challenges of using the blog. Lastly, a close-ended questionnaire was administered using the themes that emerged from the focus group interviews to summarise the experiences and challenges of using the blog, thus following the principles of the mixed-method evaluation design. To explore whether the use of the blog can improve the results of the learners, a comparison of secondary and primary data between learners who used the blog and those who did not use the blog was conducted. There was also a comparison of the results of learners who used the blog before and after the blog.

5.2 Action research phase 1

This phase involved introducing learners to the blog. It was a five-day process, which involved design, customisation, and basic interaction with the blog. Action research starts with *planning* the program of training and establishing background knowledge of participants, *implementing* the

program by designing, customising, and running the blog, *observing* by collecting data, and *reflecting* by analysing data and making a judgment if it is feasible to move to the next phase.

5.2.1 Planning

The planning process in this phase involves drafting a program of training learners on how to create, customise, and run the blog

5.2.1.1 Establishing background knowledge of participants

A closed-ended questionnaire was administered to establish the ICT background knowledge of participants. Firstly, learners were asked about the type of ICT they use. A study by Ndimbovu (2021) indicated that the most used ICTs by learners were smartphones, by 72% of learners. This study was no exception; 95% of the respondents confirmed a cell phone as an ICT they use. Nonetheless, a computer (or another device) with an internet connection and proper software installed is necessary for gaining access to online electronic resources (Ndimbovu, 2021). Furthermore, integrating technology is one core principle of connectivism theory, and Dawns (2022) adds that learning may reside in non-human appliances.

5.2.1.2 Knowledge of the internet and social media.

Blogging requires basic knowledge of the internet and social media. Bharatee (2023) testifies that the majority of secondary school students are quite familiar with online technologies, including watching videos and audio clips on YouTube, interacting in online discussion groups using social media sites (most notably WhatsApp, Twitter, Snapchat, and Instagram), and instant messaging. Ndibomvu (2021) highlights that it needs to be borne in mind that the participants are the generation of the 21st century (millennium generation) and were thus born when technology (generally speaking is readily available. Ndimbovu's (2021) conclusion was that the negative view regarding favorableness could well be a reflection of limited access to resources on the part of some learners, resulting from limited financial resources and inadequate infrastructure, including internet access. According to Dawns (2022), connectivism is the thesis that knowledge is distributed across a network of connections, and, therefore, that learning consists of the ability to construct and traverse those networks.

Planning also included determining the participants' perception of the blog. Dawns' (2022) view of perception is that it is the way a neural network (personal learning) interacts with the social network, and communication or conversation is the way a social network can interact with neural networks.

5.2.1.3 Using a blog to learn mathematics and ML is a good idea

In the context of learning, blogs provide a good opportunity to engage students in a centred cooperative learning environment, allowing opportunities for knowledge creation and sharing, creativity, reflection, and debate, in this case, referred to as open learning environments (Silalahi, 2017). According to Joshi (2017), ICT supports mathematics for composing, revising, editing, publishing, calculating, making connections, visualising data, finding importance, synthesising, and problem-solving. The results revealed that most participants confirmed that using a blog to learn mathematics and ML is a good idea.

5.2.1.4 Using a blog is beneficial for learning mathematics and ML.

Blogs offer various benefits in education, including higher education, among others: blogs can create a community of learning outside the classroom, making the learning process student-centred and interactive (Silalahi, 2017). The participants were able to log in to the blog from different locations to share information. Bharatee's (2023) findings revealed that online tools used by secondary school learners were mainly used to learn informally outside the school settings or simply to complement what they have learned at school. Connectivism theory recognises decentralised learning as one of the benefits of using a blog. It posits that knowledge is not only acquired through traditional means but also through online learning communities (Alam, 2023).

5.2.2 Implementation

Overall, the respondents demonstrated positive perceptions about learning about the blog. The researcher decided to move forward with the training, leading to the second blog implementation process. Participants were instructed to use Blogger.com, which is a website that allows users to create, design, and customise their blogs without any advanced IT skills. According to Simangunsong and Irvan (2023), blogs can be used as digital-based learning media because they

can be created, accessed easily and presented with various variations according to what we want. To create a blog using Blogger.com, one must have a Google account, which was not a challenge because the majority of learners had cell phones running on Android software, which is a division of Google. Appendix 5 (See section 8.7) demonstrates an example of how a blog is created, designed according to different layouts, and can be customised according to different themes. Blogger also allows the creator to create posts, view how many people have viewed the post, manage the comments, and create other pages within the blog.

5.2.3 Observation

A second questionnaire with open-ended questions and two sections was handed over to the participants. The first section was based on the perception of the blog after the participants had done the training. The second section was about the experiences of learning the blog. After the data had been collected, it was time to reflect.

5.2.4 Reflection

Thematic analysis was used to analyse the data, and the pre-existing themes from the theoretical framework aided the analysis.

5.2.4.1 Network and nodes

Connectivism is a learning theory that emphasises the importance of creating connections and building networks and recognises the crucial role that technology and social networks play in the learning process (Alam, 2023). Bharatee (2023) discovered that secondary school learners use social networking tools to make new friends and share school-related notes and videos, which helps them adapt to new learning settings. Contribution to sharing knowledge with other classmates was a perception that respondents across all grades agreed upon, with only 10% of Grade 09 respondents unsure. Duke, Harper, and Johnston (2013) add that the first point of connectivism is that individual, personal knowledge consists of a system of networks, which supplies an organisation, which in turn gives back to the system. Therefore, learning is essentially the process of creating connections between nodes and developing a network (Blewett, 2014).

. Downs (2022) clarifies that when a person learns, or when something learns, a connection is physically created between nodes or two entities in a network. Blewett (2014) explains that with connectivism, a node is anything that can be connected to another node, and this includes information, data, feelings, images, etc.

5.2.4.2 Dynamic knowledge

According to Dawns (2022), a connection exists between two entities when a change of state in one entity can cause or result in a change of state in the second entity. Knowledge is shared on the blog as students post their thoughts and read the various perspectives of others (Silalahi, 2023). The perception *"I feel a lot of ideas in my mind to share in the blogs"* received positive responses from respondents. By sharing ideas, there is no longer a scarcity of knowledge but a ubiquity of knowledge, which is forever changing. Therefore, learning in these environments is an intricate weave of both discerning what is worth knowing and making sense of what is known (Blewett, 2014). The 8th principle by Siemens (2004) explains that choosing what to learn and the meaning of incoming information is seen through the lens of a shift in reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decision. Most participants felt they had a lot of ideas in mind to write in the blog, with only three participants across all grades who were neutral

5.2.4.3 Technologically-enhanced learning

Connectivism is a learning theory for the digital age (Siemens, 2004). For something to be digital, technology has to be present, whether in the form of hardware, software, or both. Dawns (2022) argues that though the rise of digital technology was influential in the formation of connectivism, the theory is not a response to digitisation, but rather a way to use the insights derived from digitisation to address long-standing issues in the field of learning and development. Participants in this study also agreed that the blog is a useful medium for teaching and learning. However, two participants were neutral. The results revealed that some of the participants had no reliable connection. This may be the course of uncertainty. Hajaree (2020) believes that one of the many strategies to improve the mathematics achievement of South African learners includes the integration of Information Communication Technology (ICT), which is due to some researchers

who have found that using computers in mathematics education might increase learners' scores. Utecht and Keller (2019) emphasise that the power lies not in the technology platforms themselves but in the connections they foster.

5.2.4.4 Collaborative learning

With the rise of the internet and the free flow of information, the idea that learning is an individual endeavour that one undertakes alone is no longer true (Utecht and Keller, 2019). Silalahi (2017) mentions that blogs allow students and teachers to collaborate outside the classroom and give students access to curriculum content and support. The results of this study revealed that all the participants agreed that the blogs promote collaborative learning. Bharatee (2023) testifies that online activities teach students how to work together, produce digital material, think critically, expand the time-space of discourse in the classroom, and foster trust between students and instructors. Dawns (2022) concludes that, by contrast, in connectivism, knowledge is not understood as the content that is transferred from person to person, but rather, knowledge is the network that is grown and developed from interactions with other entities in the network and the world generally.

5.2.4.5 Decentralised learning

For learning to truly occur, learners must actively construct new knowledge themselves (Utecht and Keller, 2019). With decentralised learning, an educator or instructor is not the only person who provides information; many sources of information and knowledge are available to learners. Alam (2023) believes that the ability to make connections between different sources of information and knowledge is also critical, as it enables learners to construct new knowledge and adapt to new situations. On the other hand, blogs create a community of learning outside the classroom, making the learning process student-centered and interactive (Silalahi, 2017). A study by Bharatee (2023) revealed that participants admitted that they prefer to learn on their own using online resources, particularly when it comes to general knowledge.Participants in this study demonstrated positive perceptions, on average, towards learning through the blog. There were no participants who disagreed or strongly disagreed with the questions that were asked. The experiences of the participants were also positive, with many participants either strongly agreeing or agreeing. Those

who were not sure commented that it was because they missed or came late when the training took place. Ndimbovu's (2021) study showed that the lack of skill is associated with learners giving negative views about their experiences. It was safe to move to the next phase of using the blog.

5.3 Action research phase 2

This phase involves participants using the blog to learn mathematics and ML. It had already been established that the participants must own some sort of ICT device to participate. This phase followed the cyclical stages of action research as demonstrated in Figure 3.1 of Chapter 3. The same stages were also applied in Phase 1.

5.3.1 Planning

Planning frequently begins with a general idea (Harerimana, 2017). For this study, the idea was to use the blog to improve the results of the learners. Firstly, the blog uses informal language, therefore, it was important to make rules of communication and privacy. The kind of content to be shared, including the links to other websites, was advised to be strictly for mathematics and ML learning. The blog was available for learners, even those not included in the study, to use at any time. In some cases, for the study, participants were notified to visit the blog if there was work posted that needed their attention or to be discussed. This allowed the researcher to keep track of visits and whether participants were active on the blog. The method of data collection was revised during this stage and was changed from open-ended questionnaires to focus group interviews. The plan was for learners to use the blog for homework, assignments, informal tests, formal tests, and examinations for mathematics and ML. The duration of Phase Two was three months (12 weeks). Weekly informal tests are administered as part of the school policy, and the researcher was planning to use those tests as secondary data to monitor the progress.

5.3.2 Implementation

According to Harerimana (2017), this means implementing a plan, collecting and compiling evidence, questioning the process, and making changes as required. Poor utilisation of the blog was among other issues that the researcher noticed, which raised some concerns. Ndimbovu (2021) believes that the relatively small amount of time most learners spend using ICT is due to a lack of

access to ICTs, a lack of ICT skills, and a lack of internet connectivity and data. However, data collected from the participants rules out the lack of ICT skills as the contributing factor. Participants were also purposively selected on the criteria that they own ICT devices, which leaves internet connectivity and data as one of the reasons for less activity in the blog. Harerimana (2017) adds that the collection of data is an important step in deciding what action needs to be taken. At this stage, the researcher intervened by providing Wi-Fi access during the day once and sometimes twice a week for learners to access the blog. The intervention was for learners to stay motivated to use the blog and see the value in having it as a method of learning. However, the intervention was not enough, research was needed to conduct focus group interviews to get more data from the participants about the challenges of using the blog.

5.3.2.1 Focus group interviews

Focus group interviews aimed to get descriptive data about the challenges that the participants were facing and to help the researcher ensure the smooth running of the blog and make changes if necessary. After the collection of the data, thematic analysis was done and yielded three key themes, which are discussed in detail below.

(a) Technical issues

Khalid and Zakaria (2016) mention that a factor that becomes an obstacle to the implementation of ICT in the teaching of mathematics is limited technological resources when teachers or students are at home. For this study, technical issues are problems concerning network availability where learners live and the connection speed. Some participants raised concerns about the network speed.

Slow connection contributes to the loss of interest in visiting the blog. A study by Matlala (2015) on internet usage by Grade 11 learners indicated that slow download speeds were a problem in using the internet and time wasting. Ndimbovu (2021) shared the same view that the external barriers that are common to learners include slow and poor internet connections. Another issue that was classified as a technical issue is load shedding. Network towers do not have backup generators due to theft and vandalism. As a result, the network does not operate properly when there is no electricity. Other participants raised issues like the inability to charge their cell phones when the power is down.

[Grade 11 ML respondents] “Load shedding makes it difficult to collaborate and discuss our homework as a group, we cannot charge our phones, and the network is very slow when there is no electricity”.

(b) Real-time connection

In the blog, you can directly interact through the comment feature so that when used in learning, if the blog author is a teacher, the learning will be done lively (Simangunsong and Irvan, 2023). Blogs allow learners to engage in live discussions. However, to be online at the same time, learners need to agree on a time that will be convenient for them to be online at the same time. It is almost impossible for a large group to be online simultaneously. Simangunsong and Irvan(2023) recommend that if the teacher wants to use the blog as a learning medium, the teacher should be the one who makes the blog so that the learning content can be adjusted to the material and lesson implementation plan. For this study, training was provided to participants, and the majority strongly agreed that they had the skills to organise lesson material or assignments. It is also up to the learners to organise and decide on the time that will be convenient for them. The participants raised some concerns during the focus group interviews.

Participants seem to have one issue in common, which is the inability to be online at the same time. However, Posts in the blog are arranged regularly according to certain criteria, usually by setting the order of the date (Simangunsong and Irvan, 2023), which means information is not lost, and those who were not part of the discussion can catch up and post their views.

(c) Internet connection and affordability

A blog requires an internet connection. Sutherland (2021) explains that;

> Despite the growing use of mobile broadband, complaints about high prices became demands that #DataMustFall. The government pressed operators to cut mobile data prices, and two ministers separately directed the Competition Commission and the Independent Communications Authority of South Africa (ICASA) to investigate and act. After three years, the former identified discrimination against the poor and forced concessions from the operators

In a study by Ndimbovu (2021), learners were asked what problems they encountered when using ICTs. Interestingly, access to ICTs per se did not emerge as a problem, but rather, the "Cost of access to ICT" was mentioned by the largest number of learners. The participants of this study expressed similar views in terms of the cost of data. Sometimes learners opt for different networks that are perceived to be cheaper than others. Vodacom and MTN are some of the networks that are perceived to be expensive, yet provide good network connections. The study by Ndeuthi, Miheso, and Amuko (2015) reveals that most students have access to the Internet during Mathematics lessons because of high data costs.

5.3.3 Observation

In education research, the observation could include observation of student interactions, student work analysis, surveys and interviews, pre- and post-tests, or analysis of standardised achievement tests (Harerimana, 2017). The researcher took advantage of weekly informal tests administered as part of the school curriculum policy and used them as a way of tracking the progress of participants. The advantage was that every learner took those tests, even those who were not part of the study. The information from this observation only answered one research question: whether the blog could be used to improve the results of the learners. After the duration of Phase 2, a closed-ended questionnaire was administered, and secondary data and primary data were used to conclude the effectiveness of the blog.

5.3.4 Reflection

In this stage, a researcher is analysing and interpreting the data from observations. Two methods were used to collect the data. Focus group interviews were used to collect descriptive data about the challenges the participants came across, and closed-ended questionnaires were used to summarise the experiences the learners had when they were using the blog. Lastly, secondary data and primary data were used to determine the effectiveness of the blog in improving the results of the learners.

5.3.4.1 Close-ended questionnaire results

The themes from focus group interviews were used to construct the questions of a questionnaire.

This questionnaire aims to find out more about the experiences of the participants while using the blog to answer the second research question.

(a) Technical issues

Two questions were asked in this section

(i) Network/reception availability

Participants had already raised issues about the availability of the network in areas where they reside. Grade 09 had 75% of learners who agreed to have network reception, 10% had it sometimes, and 15% did not have it at all. Grade 10 mathematics and ML respondents, 80% and 20%, agreed to have reception and sometimes had reception, respectively. According to Joshi (2017), a variety of factors can be found to affect the use of technology in pedagogical practices, like infrastructure-related factors.

(ii) Network/signal strength

Poor connection was also raised as a concern by the respondents during the focus group interviews. In Grade 09, 40% of respondents confirmed having a strong signal. The effect of poor signal contributes to the time spent by learners on the blog because it contributes to learners losing interest in blogging. Grade 10 mathematics had 20% of respondents confirmed to have a strong signal, and Grade 10 ML had 10% who had strong signals. Zakaria and Khalid (2016) mention that limited technological resources when learners are at home is one of the obstacles of implementing IT

(b) Real-time connection

Three questions were asked in this section to get quantitative data about the learners' participation in the blog.

(i) Real-time access

In this question, the researcher wanted to know if the participants attended the live blog discussion that they arranged with other participants over the blog. There were no cases of respondents who could not access the blog in real time. Silalah (2017) describes a blog as a means of delivering information online that has internet features that can penetrate the boundaries of space and time. Due to technical issues raised by the participants, some participants attended the blog occasionally.

(ii) Real-time participation

Accessing the blog in real-time also required participants of the study to participate in the live discussions that were taking place. Participation involved posting on the blog and commenting on other participants' posts, sharing information and links, and being active in the discussions. From this data it was not clear whether those who didn't participate were online during the discussion or not, the same goes out for those who participated sometimes, it was not clear where they were online and chose not to participate or whether they were simply not online. Blogs support collaborative learning by enhancing knowledge acquisition, knowledge sharing, and reflective processes (Kuo, Kuo, and Belland, 2017).

(iii) Missed group discussion follow-up

The reason for those who did not participate was not clear; it could be that they were not online, or they were online and chose not to contribute. A researcher needed to know if those who were not online during the blog made any follow-ups or catch-ups on some topics that were discussed. Weblogs or blogs are text documents, images, media objects and data that are arranged hierarchically and according to a certain chronology that can be viewed via an internet browser (Simangusong and Irvan, 2023). This feature enabled participants to catch up on missed online discussions. There were no cases of respondents who made no follow-up.

(c) Internet Connection and Affordability

In this section, the researcher wanted information about the issues of affordability. In the literature, the cost of the internet has been identified as one of the obstacles to using ICT in education. The participants also raised the issue of data being a problem for them in the focus group interviews. It must also be noted that this study involves school children who are not employed. They are still under the supervision of parents and guardians. Three questions were asked in this section.

(i) Preferred connection method

With the high price of data and poor connection, participants had to find other ways of connecting to the internet. Normally, the options available are limited to cellular data and Wi-Fi. The study revealed that 40% of Grade 09 participants rely on cellular data, and 60% preferred Wi-Fi. For Grade 10 mathematics participants, 20% and 80%

preferred cellular data and Wi-Fi respectively. The ML class had 60% who preferred cellular data, and 40% who preferred Wi-Fi. Grade 11 mathematics had 40% who preferred cellular data, and 60% who preferred Wi-Fi. For the ML class, it was 50/50 for cellular and Wi-Fi. These results represent what the learners preferred, which can be classified as what they used most. This does not mean they did not use the options they did not choose in the questionnaire.

(ii) Network service provider.

There are two dominating service providers in South Africa known for charging higher prices for their services, and two more have recently entered the market (Surtherland, 2021). In this question, participants were given an option of the four most popular network providers and an option to add any network that was not included. Telkom is generally known to be cheap by the respondents. During the focus group interviews, respondents mentioned that Cell C and Telkom sometimes offer data deals that are reasonable and affordable. There were no Vodacom users.

(iii) Internet Data affordability

It was already established that the data is expensive and that other participants prefer Wi-Fi over cellular data. However, this does not mean that learners do not use cellular data. A study by Simangunsong and Irvan (2023) revealed that the constraints of using digital-based media such as a blog are expensive and make students sometimes complain because of internet costs. The data also revealed that participants were comparing and choosing their service providers based on the costs.

On average, only a few respondents were positive that they could afford the data, while the majority can sometimes afford it. However, the fact that the majority of participants preferred Wi-Fi and also chose service providers that provide better data deals gave hope that participants would use the blog and try every alternative available to them.

After training for the blog, the participants had positive perceptions and experiences. In Phase 2, focus group interviews gave some insight into the challenges the participants encountered. The last questionnaire went deep to question the participants' experiences using themes from their challenges.

5.3.4.2 Secondary and Primary Data Comparison

The last step was to answer the last research question: Can using a blog in learning mathematics and ML help improve the learners' results? This process made use of secondary data and primary data. Secondary data was extracted from the school records of the September Trial Examinations and it included the results of all learners, including the participants of the study. Primary data is data that is created for research purposes. A test was given to all the learners at the end of three months of running the blog, and every learner wrote the test. This test was not part of the curriculum, it was for research purposes. It is recorded as "Results after Using the Blog". The researcher made sure that the test conducted after the blog had most of the content that was assessed in the September Trial Examination for accurate results. The weekly informal tests were used during the implementation stage of Phase 2, to keep track of the participants and help them make use of the blog to learn.

(a) Secondary and Primary Data Comparison

Boxplots were used for a clear summary of data. It was mentioned in Chapter 4 that the boxplot provides a quick visual summary of the considered data set. Location (through median and quartiles), spread (using the interquartile range), shape (position of the median in the box), and possible outliers (values beyond the fences) are simultaneously observed with the boxplot (Morales, Giraldo, and Torres, 2021).

For Grade 09 learners, there was no change in terms of the maximum marks that learners obtained before and after the blog. Grade 10 mathematics experienced an increase in the minimum Grade 10 ML learners managed to increase the minimum mark a learner can get from 0 to 3 marks. The literature review from Chapter 2 mentioned that mathematics remains the most poorly passed subject, and getting a minimum of zero to three out of fifty is evidence that there is a lot that still needs to be done. The average mark for Grade 11 mathematics learners before the blog was 18.52, and it increased to 25.22 after the blog.

This data revealed an average increase in learners' marks after using the blog, but it was difficult to conclude that the cause was the blog. In some cases, the comparison revealed a decrease in the

marks after using the blog. Concluding that the marks increased because of the use of the blog would have meant the decrease in the marks was the opposite, which may not always hold.

(b) Comparison of marks before and after the blog

The researcher needed to get closer to conclude whether the blog is effective. In doing so, the comparison was done only for participants using the blog. The comparison was between their marks before the blog and their marks after the blog. In making this comparison, more variables were included with motivation from the literature. In a study done by Zakaria and Khalid (2016), three comprehensive tests were given to both the control group and the experimental group, involving the same questions. They found a slight increase in students' achievements and their interest in the topic among the experimental group. They enjoyed the Excel assignments and increased their overall understanding of algebra, which blended well with computers and technology.

(i) Marks analyses for respondents who had real-time access to the blog.

To get more accurate data, it was decided that the people who could give accurate data were those who were part of the online discussions, regardless of participation. Respondents who agreed to have real-time access to the blog demonstrated an increase in the average marks after using the blog. The Increase in average learners who access the blog in real-time is also supported by Silalahi (2017), who discovered that students enjoyed blogging because it exposed them to a variety of opinions and perceptions, thereby improving their learning.

(ii) Marks analysis for respondents who participated in real-time discussions

Participating in live group discussions is another form of collaborative learning that happens in real-time. Harerimana (2017) explains that during engagement with e-learning instructions, collaboration indicates the involvement of teachers, students, and peers in an academically constructive way. Kuo, Belland, and Kuo's (2017) supporting statement is that research has indicated that blogs can serve as effective teaching and learning tools to support students' active participation through collaboration and increase learners' motivation to learn the subject.

(iii) Marks for respondents who do a follow-up after missing real-time discussions

Blogs have the potential to benefit all students, even inactive online learners who just read the blog posts (Silalahi, 2017). The material is uploaded correctly by the procedures in the blog so that the material can be reviewed anywhere, anytime (Simangunsong and Irvan, 2023). Learners who have missed the online discussion that happened in real-time can catch up by going through the posts at a time convenient for them. Participants across all grades agreed to make follow-ups after missing the real-time connection, which enhanced their learning.

5.4 Summary of the chapter

This chapter was on the discussion of results using connectivism as a theoretical framework that underpins the study and the literature. The study also revisited the research questions to find out if the data was able to address these questions. A closed-ended questionnaire was distributed before the beginning of Phase 1. A second closed-ended questionnaire was administered to evaluate the perceptions after using the blog. The participants responded positively and agreed to some of the critical skills that have been accumulated during training. Focus group interviews were administered during Phase 2 to address the challenges of the blog. A second questionnaire that was distributed after Phase 2 also addressed the question of the experiences of participants after using the blog. The comparison of marks before and after the blog was conducted involving all learners. The data before the blog was secondary data, and the data after the blog was primary data. The results revealed performance improvement. However, it was not concluded that the improvement was due to the use of the blog. A comparison that involved only the participants, under three topics, was conducted. Participants were evaluated under real-time access, participation, and follow-ups. The results were in line with the literature that using technology in learning mathematics/ML creates learner interest and can be used to improve the performance of learners.

6. CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

The study's results are presented in Chapter Four. Chapter Five provides a discussion of the results. This chapter begins with an overview of the research and outlines the implications of the main findings. Before discussing the limitations of the study and making recommendations for further research, implications for the researcher's practice will be addressed.

6.2 Overview of the study

The study occurred at Thornwood Secondary School in Marianhill, Pinetown, where the researcher teaches mathematics and ML. The study participants are learners from Thornwood from Grade 09 to Grade 11, who were purposively selected on the criteria that they own ICT devices. It was also convenient for the researcher to choose these learners because he teaches them. Ethical issues were considered, and parental/ guardian consent was required before collecting data because of the age of the participants. The poor performance in mathematics and ML was the main trigger for undertaking this study. As a result, the study's objective was to explore whether using the blog can improve the results of mathematics and ML in Grades 9 to 11. The second objective was to explore the learners' perceptions and experiences towards using the blog. Furthermore, in doing so, the study had to answer three research questions;

I. What are learners' perceptions and experiences towards using the blog?
II. What are the key challenges of using the blog?
III. Can the use of a blog in learning mathematics and ML help improve the learners' results?

The study is divided into six Chapters that discuss unique elements of the study. The structure of the dissertation is as follows;

Chapter One: *Introduction*. This chapter discusses the general problem area, research questions, and objectives. It also discusses the importance of the research, the research approach, limitations, and key assumptions.

Chapter Two: *A Literature Review*. This chapter discusses prior research and provides the background and context of the study. It will review published and unpublished research**.**

Chapter Three: ***Description of research methodology and theoretical framework.*** This chapter discusses the methodology and methods used to collect data and explains the theories that underpin this research.

Chapter Four: ***Research Results.*** This chapter presents the results using tables, graphs, and themes.

Chapter Five: ***Analysis of results.*** This chapter discusses the conclusions drawn from the data.

Chapter Six: ***Conclusion and Recommendations.*** This chapter summarizes the research with emphasis on the results and their contribution, recommendations, and suggestions for further research.

6.3 Implications of the main findings.

The study's three research questions guide the outline of the conclusion of the main findings.

6.3.1 What are learners' perceptions and experiences towards using the blog?

The ages of the learners who were participants in this study ranged from 14 years to 17 years, meaning they were born between 2007 and 2010. The generation born during these years is known to be technology savvy. They are born in an age where technology is rapidly growing, including the Internet and, the availability of tablets, and smartphones. In every household, the likelihood of not having a smartphone is very minimal. During these years most social media used today was already in use when these learners were born. The researcher started by developing the participants' background knowledge to discover how much knowledge they have about the digital world. This background knowledge involved asking how much the participants knew about the internet and social media. This question was motivated by the fact that the blog requires knowledge of the internet and some social media elements. All participants were familiar with the use of the internet.

The researcher also wanted to know if the learners were familiar with the blog, or blogging. Few participants were familiar with the blog. As a result, the researcher had to explain what a blog is to the participants, including the blogging process.

Firstly, the participants were asked if they thought that learning through the blog was a good idea. The responses were mostly positive. Unfortunately, there was no room for participants to explain why because the data collected was quantitative. The literature has shown that learners born during this era enjoy social networks and using their smartphones. Using the blog also meant that these learners could learn even after school using smartphones, this made them more interested in the idea of learning using the blog.

The second question asked the participants if they perceived learning through the blog as beneficial. When the blog's concept was explained to the participants, the benefits and drawbacks were explained as clearly as possible. Most participants perceived the learning through the blog beneficial because of the idea of learning at home, with a smartphone in a social media-like environment where they can use informal language, was appealing to them.

Lastly, participants were asked how they felt generally about learning using the blog. The overall responses of participants were enough to conclude that the perceptions of using the blog were positive. As a result, the researcher was confident that training to use the blog could begin.

After the training was complete, the participants' perceptions were questioned again using an open-ended questionnaire. The participants' experiences were also questioned, and the questions were open-ended allowing them to elaborate if necessary. Pre-existing themes extracted from the theoretical framework were used to guide the questions asked in a questionnaire. Five questions were asked to address the learners' perceptions after the training, and five questions were also asked to address their experiences after training for the blog.

Learners' perceptions

The first question about the perception was whether the participants would like to contribute to sharing knowledge with their classmates. Almost everyone was willing to share knowledge, except for two learners who were worried about the language and the learners who might post nothing. This problem can be addressed by reminding the learners about the rules of posting in the block, more especially the language.

The second question asked if participants felt like having any ideas on their minds that they could post on the blog. Most respondents are equipped to share their ideas. Two learners, however, were not sure but gave assurance that they would use search engines like Google to advance their knowledge so they could share as well. The participants were asked if they felt the blogs were useful mediums for teaching and learning. Drawing from the results, most participants found blogging useful in the field of teaching and learning.

Positive responses were received when the participants were asked if they felt like the blog promoted collaborative learning. Posting comments, commenting on one's post, and sharing ideas and information are among the features of the blog that promote collaborative learning. Previous studies have shown that blogs promote collaborative learning with their inherited feature of social networks. This makes them a desirable method of learning.

The last question on perceptions was if the participants felt confident in deepening their mathematics/ML lessons using the blog. They felt they could use the blog to add to the information they learned in class.

All in all, there was no significant change in the perceptions of the participants after training for the blog, they remained positive about the blog. It is a good medium of teaching and learning that promotes collaborative learning and can allow learners to deepen their knowledge of mathematics and ML.

Learners' experiences

Questioning the experience of learners began after the training for the blog with the use of an open-ended questionnaire. Participants were asked five questions which were extracted from pre-existing themes of the connectivism learning theory.

Firstly, participants were asked if they were skilled in linking their blogs to other blogs. According to the connectivism theory, learning occurs through creating and strengthening connections. In connecting the blogs, participants are fostering and strengthening their connections for productive learning. The skill was shared with the participants and the all agreed to have understood it.

The skill of organizing lesson material and assignments on the blog was critical for the proper arrangement of content available in the blog. Many participants agreed that through the experience of blogging, they are now in possession of this skill. The literature also mentioned the wide availability of information in the online environment, therefore, organizing information for convenient access is important.

Experience in making polls on the blog and making comments is essential in blogging and collaborative learning. It enhances communication skills and critical thinking. Participants' experience in this field was positive, they agreed and strongly agreed that they had skills in making polls or other people's comments.

Lastly, the participants were asked if they had skills in creating hyperlinks to websites that could expand their knowledge. participants could utilize the blog to accumulate more information. Furthermore, information is no longer available solely from educators; learners have the privilege to extract information from multiple sources. On average, it can be concluded that participants had positive experiences and gained many skills in training.

Nonetheless, the experiences questioned were related to the blog's training. After running the blog, the researcher collected data on the participants' experiences using a closed-ended questionnaire and categorized the data according to the three themes that emerged from the focus group discussions.

Technical issues

Using technology for learning has its drawbacks and benefits. Participants were asked two questions about their experiences in terms of technical issues. Firstly, the experiences with network availability. The participants' responses revealed that there are network related issues among the participants. Although it is not alarming, the data reveals that most participants have the network where they live. It was fortunate that only a few had a problem with zero connection. This experience was beyond the participants' control, those who are lucky would sometimes connect through a Wi-Fi hotspot provided by family members who use different networks with signals in those locations. This contributes to better access and usage of the blog

Having a network signal is not sufficient enough if the signal is poor. The researcher wanted to know the participants' experiences relating to the strength of the network. Most learners experienced a moderate signal. This burdens participants who wish to share audio/video files for streaming, which might lead to a dropping interest in using the blog. However, smaller files like PDFs, Word documents, and links to less graphic websites do not require a strong signal, but it is admirable to have a strong signal for fast access and navigation without waiting for pages to load. Few participants (8 of 50) had poor network reception, which led to the loss of interest in accessing the blog.

Real-time access

Having real-time access to the blog means participants can collaborate at their agreed time and tackle the mathematics and ML problems live. The connection is synchronous, participants get the responses immediately with no delay. The results from the data revealed that 7 of 50 learners had no real-time access. Probably, because of the poor signal which leads to the loss of interest in accessing the blog, and the unavailability of a network in areas where they live. As bad as it seems, more learners confessed that they could access the blog in real-time. The results gave the researcher hope that the attendance and utilization of the blog are not in crisis.

However, having real-time access to the blog was not enough if the participants had no input into the discussions that happened in real-time. The data collected to analyze the participants' perceptions gave positive responses that the learners were confident enough to share their ideas with others. Collaborative learning in real-time gives the learners an advantage of getting quick solutions, especially for assignments due for submission.

The participants were also asked to share their experiences regarding doing the follow-ups when they missed the live discussion they had scheduled. A blog can also be used asynchronously, meaning the discussed information is not lost. By doing follow-ups leaners are able to catch up on the work they missed. The study revealed that learners do take advantage of this opportunity.

Regarding real-time access, participation, and follow-ups, the participants' responses demonstrate positive experiences. The participants were willing to use the blog for learning regardless of the

challenges that came with it. The data reveals that learners were willing to overcome the challenges and work together to learn.

Internet connection and availability

The blog cannot function without an internet connection. Therefore, the experiences of learners in this regard were worth exploring. Firstly, when the focus group interviews were conducted, participants voiced the issue of data costs. They also mentioned some of the alternatives they opt for to address the issue of high costs. It was a matter of Wi-Fi versus mobile data for the participants. The results revealed that the participants preferred Wi-Fi more than mobile data. High data cost leads to Wi-Fi usage as a cheaper option.

At times, the participants went as far as having two or more SIM cards from different network providers to take advantage of data deals that these network services provide and to address the problem of poor network signal. The participants also used both methods by turning off the mobile data when they were in a Wi-Fi hotspot zone. For the researcher, problem-solving and choosing the best alternative is part of mathematics. They were learning without being aware that they were learning important lessons in their lives.

The participants also experienced the high costs of data to the extent that some of them confessed that they could not afford the data. The majority reported that they could afford it sometimes, while 11 out of 50 agreed that they could afford it. The number of those who cannot afford it was reported to be 14 out of 50 participants. However, there was hope that within that number, others had access to Wi-Fi.

To conclude, the positive perceptions that the participants had towards using the blog played an important role in keeping them motivated to use it. Some challenges led to difficult experiences; however, the participants were resilient. They found ways to move around the obstacles, such as lack of network connectivity, poor network signals, and high data costs. They learned more than mathematics and ML, but also how to navigate through life problems. The ability to switch between networks to take advantage of the best deal and the ability to switch to a Wi-Fi connection to save mobile data cost is a skill they learned indirectly.

6.3.2 What are the key challenges of using the blog?

This question was addressed by conducting focus group interviews. The data from the respondents was analyzed and categorized into three themes; Technical issues, real-time connection, and internet connection and affordability.

Technical issues raised by the participants included network reception and signal strength. In some areas where they reside, there is no signal at all. However, this problem did not affect many participants, and they developed a solution to move around it. Having multiple SIM cards from different service providers was a solution for some learners. The problem of signal strength leads to slow loading of browser pages, which results in participants losing interest in using the internet. However, running a blog does not require too much bandwidth, unless the participants are streaming video and audio or downloading larger files. Nonetheless, the poor signal problems were not permanent, it was sometimes weak, and sometimes normal to work with. Lastly, the issue of load shedding was also raised by the participants. It affected them in charging their mobile devices, and it also affected the network signal. Load shedding is a thing of the past for South Africans, and it gives a positive future for bloggers.

Real-time connection is almost impossible for a sample of 20 learners like Grade 09 with all the challenges that come with using the blog. For smaller samples like Grade 10 and 11 mathematics, real-time connection was possible. With this challenge, it was a matter of hoping that at least a large number of participants could attend the blog in real time. Live discussions are only effective if the participants are active and make comments. This problem can be expected in the early stages of the blog when participants are still shy or not comfortable with blogging. However, as soon as they get comfortable as they are on social networks like WhatsApp and Facebook, they can search for information and have something to share. The problem is expected to simmer down. The positive side of real-time discussion problems was the fact that participants had an opportunity to do follow-ups on discussions that they had missed. Going through the comments to view information that was discussed including the links to information from outside sources is one of the benefits of using the blog. The study revealed that most participants did make follow-ups.

Internet connection and affordability were the last issues the participants raised in the focus group discussions. Internet data is expensive in South Africa, and initiatives like #datamustfall have fought a losing battle against giant companies like Vodacom and MTN. Cell C and Telkom have entered the market intending to create competition and drive the data costs data. However, the change is still not that significant. Due to the lack of infrastructure, they find themselves having to raise the costs of their services to make profits and stay afloat. In cases like these, the participants have found themselves navigating through these service providers to take advantage of the data deals and packages that these service providers offer. Wi-Fi connections and hotspots were another solution the participants opted for.

Having discussed these challenges in the focus group interview, the participants still managed to access the blog in numbers to take advantage of this learning method. Their challenges taught them problem-solving skills and not to give up on what they perceived to be beneficial for them.

6.3.3 Can the use of a blog in learning mathematics and ML help improve the learners' results?

With the gatekeepers' permission, secondary data from the school records was used to create an overall picture of how the learners, in general, were performing in both mathematics and ML. The data included all learners from Grade 09 to Grade 11. At the end of Phase Two, which took three months, a test was written by all learners. Therefore, this test was for research purposes and not part of the school assessment. Therefore, it became the primary data for the study. A comparison of the average marks of learners before using the blog and after using the blog was made, and the data showed some improvements across all grades. Literature has revealed that in some cases the use of a blog for learning creates independent thinkers and interest in the subject. Some studies have also shown that in mathematics learner attitudes towards the subject have an impact on the performance of learners. Learners who enjoy the subject tend to perform better. However, the researcher felt that it was not sufficient to conclude that the average in the marks increased because of the blog. The one-way ANOVA test was run on the data of the learners who participated in the blog. This test was run with the lens focused on their real-time access to the blog, how they participated in real-time discussions, and their ability to make follow-ups on missed live discussions. The data revealed that there was an increase in the average mark for participants who

had real-time access to the blog and a decrease in those who did not. There was also an increase in average marks for those participants who participated in real-time discussions and those who made follow-ups when they could not be part of the discussions. For the researcher, this data and the literature that supported the results were close to concluding that a blog can be used to improve the results of the learners in mathematics and ML.

Blogs possess the elements of social media, they promote collaborative learning, they create learner interest, and they provide learners with multiple streams of learning. Some studies have revealed that some learners prefer to learn in the comfort of their homes and that informal learning is becoming a new way of learning. Literature also supports the idea that learning mathematics online provides learners with graphical information they provide more clarity to some concepts that cannot easily be understood using the chalkboard alone.

All in all, the blog provides a learning environment that creates learner interest in mathematics and ML, which contributes to the improvement of performance and results. The data backed up by the literature is evidence that the marks of the learners improved because of using the blog.

6.4 Implications for the researcher's findings

The trigger for undertaking this study was the poor performance of learners in both mathematics and ML. As a researcher, the obvious problem was learner interest in the subject, but through the review of the literature, other problems were discovered that had an impact on the poor performance of learners. Unfortunately, some of the problems were beyond the researcher's control. They range from the poor background knowledge of mathematics, mathematics anxiety, and lack of support at home, to society's views and stereotypes about the subject. As the researcher, there was a belief that if the learners' attitude can change from negative to positive, there will be interest in the subject. From previous experience, if one has a passion for the subject there is always a will to work hard and perform better. Proposing the blog was motivated by observing how this generation of learners spent most of their free time on their phones and social media. Integrating a subject, they do not like with what they like seemed to be a viable option with the possibility of making learning more interesting.

The learners welcomed the idea with positive perceptions, though there were challenges they experienced. One of the major challenges was data cost, at some point the researcher had to use his data to create a Wi-Fi hotspot for learners to create interest in the use of the blog. A few learners requested that previous question papers be posted on the blog, so they can download them and share them with other learners on other platforms like WhatsApp. They helped a researcher and other learners prepare for exams and formal tests. There was also a shift from traditional learning to digital learning. Surprisingly, some learners were not included as participants in the study but used the blog because everyone had free access.

To conclude, introducing the blog to the learners was a game-changer, and if the school had Wi-Fi access like public libraries, learning methods like blogs could thrive.

6.5 Limitations of the study

This study had its share of limitations. The most felt limitation was the internet data affordability. The participants are minors with no source of income. They depend on their parents and guardians to provide them with pocket money. That pocket money is not enough to afford them internet data due to high costs. Other parents believe that having internet data is a distraction to their children because of social networks. This challenge limited learners to access real-time access and live discussions.

The second limitation was network availability in areas where the learners reside. Learners often raise a concern that in places where they live, they hardly get the network reception. That meant they could not access the blog when they were at their home. Poor connection often resulted in slow loading of pages which limited learners in streaming audio and video files. This resulted in the loss of interest in the blog.

Lastly, issues like power cuts induced by load shedding and overloading of electric transformers limited some learners, but the problem was not severe enough to be studied. The researcher also provided his data for Wi-Fi hotspot access. In doing so, he was trying to keep the learners interested in the blog, and it led to learners trying different means to stay connected.

6.6 Recommendation for further research

Using a blog to learn mathematics and ML was an interesting journey. Employing action research to facilitate this process was also educative for me as a researcher. Learner attitudes have a very huge impact on how learners relate to a subject. Many factors shape how a learner relates to a subject, and knowing these factors may help educators change their method of approaching the subject. For subjects like mathematics and ML, the background knowledge of learners is important. Educators must be familiar with the kind of learners they are dealing with to help understand the approach or teaching methods that will develop learner interest.

As educators, we are living in a digital age. The integration of technology to learn subjects like mathematics and ML needs more attention. Social media has taken the youth by storm, and more research should be done on how it can be integrated with learning. The internet has become the hub of information that provides limitless access independent of space and time. Collaborative learning allows learners to communicate anywhere in the globe based on common subjects. More research needs to be done on how learning platforms like blogs can be extended to include international learners.

If South Africans are doing poorly in mathematics, how can we use blogs to collaborate with learners from other countries that are doing well? We also need to improve the level of our network infrastructure to be on a global standard. More research and initiatives should be done to address the problems of internet connectivity and internet costs, respectively. This will eliminate the problem of being reluctant to access the internet.

Further emphasis should be on the government to provide ICT infrastructure at schools and safeguard the infrastructure against theft and vandalism. If public institutions like libraries can provide internet access for free, schools can do it, too. Schools are where this infrastructure is needed most.

6.7 Summary of the chapter

The combination of technology and education cannot be avoided. Learning has become more interesting if it is done using technology. Books are becoming digital, and complex mathematical problems can easily be solved using specified mathematical software and demonstrations.

Knowledge no longer resides in one individual but can be found in different networks. One of the objectives of the study was to explore if the use of the blog can improve the results of grades 9 to 11 for mathematics and mathematical literacy (ML). Through different comparisons, the data revealed an increase in average marks after using the blog. Indeed, using a blog had an impact on increasing learner performance. The second and last objective was to explore the learners' perceptions and experiences towards using the blog. The learners perceived the blog as a good and beneficial medium of learning. They experienced poor network availability and signal strength, and high data costs. They also experienced creating and running blogs, including sharing links, ideas, and collaborative learning through real-time discussions. Despite some challenges, it never stopped the learners from using the blog. It only taught them to improvise, adapt, and overcome.

7. REFERENCES

Acharya, B. R. 2017. Factors Affecting Difficulties in Learning Mathematics by Mathematics Learners. *International Journal of Elementary Education, 6*(2): 8-15. http://www.sciencepublishinggroup.com/j/ijeedu/10.11648/j.ijeedu.20170602.11 accessed 04 February 2024

Adler, J. Pillay, V. 2016. Mathematics education in South Africa. In Research for Educational Change. Routledge. https://www.taylorfrancis.com/chapters/edit/10.4324/9781315643236-3/mathematics-education-south-africa-jill-adler-vasen-pillay accessed 23 July 2024

Ajai, J.T. Imoko, I.I. 2015. Gender differences in mathematics achievement and retention scores: A case of problem-based learning method. *International Journal of Research in Education and Science (IJRES), 1(*1):45- 50. https://files.eric.ed.gov/fulltext/EJ1105194.pdf accessed 29 September 2024

Ajayi, V. O. 2017. Primary sources of data and secondary sources of data. *Benue State University*, *1*(1): 1-6. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Primary+sources+of+data+and+secondary+sources+of+data.+Benue+State+University%2C+1%281%29%3A+1-6.&btnG=#d=gs_cit&t=1737884746269&u=%2Fscholar%3Fq%3Dinfo%3Ay44yiMhQhI4J%3Ascholar.google.com%2F%26output%3Dcite%26scirp%3D0%26hl%3Den accessed 1 January 2025

Akinoso, O. 2018. Effect of the Use of Multimedia on Students' Performance in Secondary School Mathematics. *Global Media Journal, 16(*30): 1-8. https://www.proquest.com/openview/f5daff788aa2d39f7cfc354aa643f672/1?pq-origsite=gscholar&cbl=29638 accessed 14 January 2024

Alam, M. 2023. Connectivism Learning Theory and Connectivist Approach in Teaching and Learning: A Review of Literature. *Bhartiyam International Journal of Education and Research*, *12*(2), 1-15. researchgate.net/profile/Md-Alam-721/publication/369734538_Connectivism_Learning_Theory_and_Connectivist_Approach_in_T

eaching and Learning A Review of Literature/links/64298e4a315dfb4ccec853d5/Connectivism-Learning-Theory-and-Connectivist-Approach-in-Teaching-and-Learning-A-Review-of-Literature.pdf accessed 15 August 2024

Amuko, H. Miheso, M. Ndeuthi, S. 2015. Opportunities and Challenges: Integration of ICT in Teaching and Learning Mathematics in Secondary Schools, Nairobi, Kenya. *Journal of Education and Practice, 6* (24): 1-6. https://files.eric.ed.gov/fulltext/EJ1078869.pdf accessed 24 January 2024

Asghar, J. 2013. Critical Paradigm: A Preamble for Novice Researchers. *Life Science Journal, 10* (4):3121-3127. https://www.lifesciencesite.com/lsj/life1004/ accessed 10 June 2024

Bansilal, S. 2014. Exploring the notion of Mathematical Literacy teacher knowledge. *South African Journal of Higher Education*, *28*(4): 1156-1172. https://journals.co.za/doi/abs/10.10520/EJC159193 accessed 12 January 2024

Bansilal, S. 2016. Teachers' understanding of inflation: developing a crystalline concept. *International Journal of Mathematical Education in Science and Technology*, *48*(1), 83–93. https://doi-org.ukzn.idm.oclc.org/10.1080/0020739X.2016.1238517 accessed 6 October 2024

Bansilal, S. Pillay, E. 2019. Negotiating the Demands of Teaching Mathematical Literacy. *Africa Education Review, 16*(3): 84-100. https://doi.org/10.1080/18146627.2017.1340807 accessed 6 October 2024

Bertram, C., and Christiansen, I. 2014. *Understanding research: An introduction to reading research*. Pretoria: Van Schaik Publishers. https://web-s-ebscohost-com.ukzn.idm.oclc.org/ehost/ebookviewer/ebook/bmxlYmtfXzEyNDMwNDlfX0FO0?sid=8b32a55d-a8b3-463b-b12a-48198b351db1@redis&vid=0&format=EB accessed 25 March 2023

Bhargava, A. Pathy, M, K. 2014. Attitude Of Student Teachers Towards Teaching Profession. *Turkish Online Journal of Distance Education-TOJDE, 15*(3): 27-36. https://files.eric.ed.gov/fulltext/EJ1078869.pdf accessed 24 December 2023

Blewett, C. 2014. Learning in a Facebook environment: The writing is on the wall. Edgewood. University of KwaZulu Natal. https://researchspace.ukzn.ac.za/items/2021ac76-b394-40cb-a422-b13ac670cdca accessed 15 June 2024

Botha, H. Maree, J. Stols, G. 2013. Mathematical Literacy teachers: Can anyone be one? *Perspectives in Education, 31(4).* https://repository.up.ac.za/bitstream/handle/2263/40030/Botha_Mathematical_2013.pdf accessed 12 September 2023

Botha, H. van Putten, S. 2018. How Mathematical Literacy Teachers Facilitate Mathematisation in Modelling Situations. *African Journal of Research in Mathematics, Science and Technology Education*, *22*(1): 93–102. https://doi-org.ukzn.idm.oclc.org/10.1080/18117295.2018.1437337 accessed 05 October 2024

Brijlal, P. 2013. An exploration of the contributions of the advanced certificate in education in mathematical literacy programme towards the professional development of teachers in KwaZulu-Natal. Durban. University of KwaZulu-Natal. https://researchspace.ukzn.ac.za/server/api/core/bitstreams/6df0e063-56b5-417a-b63e-5e2b1dabffdf/content accessed 12 January 2024

Butakor, P. K. 2018. The home environment as a predictor of mathematics achievement in Ghana. *International Journal of Research Studies in Education 1*(7): 1-13. https://www.researchgate.net/publication/312872746_The_home_environment_as_a_predictor_of_mathematics_achievement_in_Ghana accessed 5 October 2024

Cele, R. D. 2015. Attributes to poor results performance in mathematics by KwaZulu-Natal Department of Education. Durban. University of KwaZulu-Natal. https://researchspace.ukzn.ac.za/items/18e0f8ec-30e3-4d35-94c9-ba72bdb0ef33 accessed 02 January 2024

Chetty, D. 2013. Connectivism: Probing Prospects for a Technology-Centered Pedagogical Transition in Religious Studies 1. *Alternation,* 10: 172-199.

https://www.researchgate.net/figure/A-Connectivist-Framework_fig1_269071838 accessed 5 June 2023

Chimuka, A. 2017. The effect of integration of geogebra software in the teaching of circle geometry on grade 11 students ' achievement. Pretoria: University of South Africa. https://uir.unisa.ac.za/bitstream/handle/10500/23417/Ugorji%20I.%20Ogbonnaya%20,%20Chimuka%20Alfred.pdf?sequence=1 accessed 09 August 2023

Chirinda, B. Kitchen, R. Castellón, L.B. Matute, K. 2023. Teaching mathematics in post-Apartheid South Africa: the perspectives of teachers of black students, *Research in Mathematics Education, 25*(1), 105-123. https://doi.org/10.1080/14794802.2021.2024086 accessed 28 January 2024

Chu, H. C. Chen, J. M. Tsai, C. L. 2018. Effects of an online formative peer-tutoring approach on students' learning behaviors, performance and cognitive load in mathematics. In Learning Analytics pp. 61-77. Routledge. https://www.taylorfrancis.com/chapters/edit/10.4324/9780429428500-6/effects-online-formative-peer-tutoring-approach-students-learning-behaviors-performance-cognitive-load-mathematics-hui-chun-chu-jun-ming-chen-chieh-lun-tsai accessed 23 November 2023

Creswell, J. W. Creswell, J. D. 2018. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (5th ed.). London: SAGE Publications.

Das, K. 2019. Role of ICT for Better Mathematics Teaching. *Shanlax International Journal of Education, 7*(4), 19-28. https://files.eric.ed.gov/fulltext/EJ1245150.pdf accessed 27 January 2024

Demir, S. 2022. Comparison of normality tests in terms of sample sizes under different skewness and Kurtosis coefficients. *International Journal of Assessment Tools in Education, 9*(2): 397-409. https://dergipark.org.tr/en/download/article-file/2365457 accessed 30 December 2024

Dolapcioglu, S. Doğanay, A. 2020 . Development of critical thinking in mathematics classes via authentic learning: action research. *International Journal of Mathematical Education in Science and Technology*, *53*(6), 1363–1386. https://doi-org.ukzn.idm.oclc.org/10.1080/0020739X.2020.1819573 accessed 14 April 2024

Downes, S. 2019. Recent Work in Connectivism. *European Journal of Open, Distance and e-Learning*, *22*(2). https://files.eric.ed.gov/fulltext/EJ1245809.pdf accessed 14 August 2024

Downes, S. 2022. Connectivism. *Asian Journal of Distance Education*, *17*(1): 58-87. http://asianjde.com/ojs/index.php/AsianJDE/article/view/623 accessed 23 March 2023

Department of Basic Education .2011. *Curriculum and Assessment Policy Statement GRADES 10-12*: Mathematical Literacy. Pretoria: Department of Basic Education. https://www.education.gov.za/Portals/0/CD/National%20Curriculum%20Statements%20and%20Vocational/CAPS%20FET%20_%20MATHEMATICAL%20LITERACY%20_%20GR%2010-12%20_%20Web_DDA9.pdf?ver=2015-01-27-154330-293 accessed 21 August 2023

Dlamini, G. P. 2016. An exploration of the teaching strategies used by mathematical literacy teachers: a case study of grade 11 teachers in Umlazi District. Edgewood. University of KwaZulu Natal. https://researchspace.ukzn.ac.za/server/api/core/bitstreams/4c02b381-b39b-4eca-96f4-3ecead5a4f9e/content accessed 29 December 2023

Dube, N. H. 2019. Exploring secondary (9, 10 & 11) Mathematics and Science teachers' usage of the curriculum tracker in Pinetown and King Cetshwayo Districts. Durban. University of KwaZulu Natal. https://researchspace.ukzn.ac.za/handle/10413/17645 accessed 5 October 2024

Duke, B. Harper, G. Johnston, M. 2013. Connectivism as a Digital Age Learning Theory. *The International HETL Review, Special Issue:* 4-13. https://www.hetl.org/wp-content/uploads/2013/09/HETLReview2013SpecialIssue.pdf#page=10 accessed 23 March 2023

Elg, M. Gremyr, I. Halldorsson, A. Wallo, A. 2020. Service action research: review and guidelines. *Journal of Services Marketing 34* (1): 87-99. https://www.emerald.com/insight/content/doi/10.1108/JSM-11-2018-0350/full/pdf?title=service-action-research-review-and-guidelines accessed 03 June 2024

Emam, M. M. Hilal, Y. Y. Mohamed, N. Al-Mahdy, Y. F. H. 2023. Between think big and hit hard' exploring the role of teacher agency in becoming action researchers: the Egyptian context. *Educational Action Research, 31* (1): 135-152.

https://www.tandfonline.com/doi/epdf/10.1080/09650792.2022.2159470?needAccess=true Accessed 10 May 2024

Engelbrecht, J. Harding, A. 2015. Interventions to improve teaching and learning in first year mathematics courses. *International Journal of Mathematical Education in Science and Technology, 46*(7): 1046–1060. https://doi.org/10.1080/0020739X.2015.1070441 accessed 4 October 2024

Feyisa, B.M. Feyisa, B. A. Modera, K. A. Hailu, Y. 2023. The practices and challenges of conducting action research in some selected secondary schools of Bale Zone, Oromia, Ethiopia. *Educational Action Research, 31*(3): 424-436. https://www.tandfonline.com/doi/epdf/10.1080/09650792.2021.1997778?needAccess=true accessed 11 May 2024

Frenzel, J. 2021. Identity and Modelling in Mathematical Literacy: A Case Study in Designing Mathematical Literacy Investigation. Stellenbosch. University of Stellenbosch. https://scholar.sun.ac.za/server/api/core/bitstreams/f88ebbac-e2c7-43be-bef4-c0418ad6d691/content accessed 26 December 2023

Gamede, T.P. 2001. Digital Literacy among Grade 12 Learners at Centocow High School at Harry Gwala District, KwaZulu Natal, South Africa. Pietermaritzburg. University of KwaZulu-Natal. https://researchspace.ukzn.ac.za/server/api/core/bitstreams/07a4ad15-0647-4349-a8c6-dff6088c695e/content accessed 17 December 2024

Garcia, E., Moizer, J. Wilkins, S. Haddoud, M.Y. 2019. Student learning in higher education through blogging in the classroom. *Computers & Education*, 136: Pages 61-74. https://www.sciencedirect.com/science/article/pii/S0360131519300776#sec4 accessed 6 September 2024

Geldenhuys, J.L. Kruger, C. Moss, J. 2013. Selected South African Grade 10 Learners' Perceptions of Two Learning Areas: Mathematical Literacy and Life Orientation. *Africa Education Review, 10* (2): 298-322. https://www-tandfonline-

com.ukzn.idm.oclc.org/doi/epdf/10.1080/18146627.2013.812282?needAccess=true accessed 23 December 2023

Genc, M. Erbas, A. K. 2019. Secondary Mathematics Teachers' Conceptions of Mathematical Literacy. *International Journal of Education in Mathematics, Science and Technology (IJEMST), 7*(3): 222-237. https://ijemst.org/index.php/ijemst/article/view/611 accessed 28 December 2023

Goos, M., O'Sullivan, K. 2023. The Evolution and Uptake of Numeracy and Mathematical Literacy as Drivers for Curriculum Reform. In: Shimizu, Y., Vithal, R. (eds) Mathematics Curriculum Reforms Around the World. New ICMI Study Series. Springer. https://doi.org/10.1007/978-3-031-13548-4_21 accessed 4 October 2024

Gordon, S . P. Solis, R. D. 2018. Teacher Leaders of Collaborative Action Research: Challenges and Rewards. *i.e.: inquiry in education,10(*2). https://digitalcommons.nl.edu/ie/vol10/iss2/3 accessed 13 April 2024

Graham, M. A. 2023. Overcrowded Classrooms and their Association with South African Learners' Mathematics Achievement. *African Journal of Research in Mathematics, Science and Technology Education*, *27*(2): 169–179. https://doi.org/10.1080/18117295.2023.2244217 accessed 11 August 2024

Hansraj, S. 2021. Exploring the use of technology-based teaching methods when teaching shape and space in grade 10 mathematical literacy. https://researchspace.ukzn.ac.za/bitstream/handle/10413/19944/Hansraj_Sharda_2021.pdf?sequence=1&isAllowed=y accessed 28 August 2023

Harajee, S. 2020. Exploring grade five learners' perceptions on the use of technology when learning fractions in one grade five class in the Ilembe district of KwaZulu-Natal, South Africa. Edgewood. University of KwaZulu-Natal. https://researchspace.ukzn.ac.za/items/9723333c-8a48-4ac3-a5bf-3b03e3728d32 accessed 28August 2024

Harerimana, A. 2017. A descriptive study on the utilization of internet as an academic tool among undergraduate nursing students, at a selected University in KwaZulu-Natal. Durban. University of

KwaZulu-Natal. https://researchspace.ukzn.ac.za/items/6ac87025-c3ed-4be1-a0b3-3c21d4197b49 accessed 27 June 2024

Henthorn, R. Lowden, K. McArdle. 2024. 'It gives meaning and purpose to what you do': mentors 'interpretations of practitioner action research in education. *Educational Action Research, 32*(2): 169-185. https://www.tandfonline.com/doi/epdf/10.1080/09650792.2022.2106260?needAccess=true accessed 03 June 2024

Herlo, D. 2017. Connectivism, a new learning theory? European Proceedings of Social and Behavioural Sciences. https://www.europeanproceedings.com/article/10.15405/epsbs.2017.05.02.41 accessed 25 May 2024

Ismail. Fitriani. Takdir. Sudirman, P., Umar. 2020. Blog-based mathematics learning devices. *Journal of Physics: Conference Series*, *1517*: 7 https://iopscience.iop.org/article/10.1088/1742-6596/1517/1/012094/pdf accessed 11 August 2023

Jackling, B., Natoli, R., Siddique, S., Sciulli, N. 2014. Student attitudes to blogs: a case study of reflective and collaborative learning. *Assessment & Evaluation in Higher Education*, *40*(4): 542–556. https://doi.org/10.1080/02602938.2014.931926 accessed 6 October 2024

Jita, T., & Sintema, E. J. 2022. Exploring Classroom Use of ICT Among Pre-service Science Teachers in Selected SADC Countries. *African Journal of Research in Mathematics, Science and Technology Education*, *26*(3), 218–236. https://doi-org.ukzn.idm.oclc.org/10.1080/18117295.2022.2139105 accessed 6 October 2024

Joshi, D. R. 2017. Influence of ICT in mathematics teaching. *International Journal for Innovative Research in Multidisciplinary Field*, *3*(1), 7-11. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Influence+of+ICT+in+Mathematics+Teaching&btnG= accessed 16 June 2024

Watson, J. B. 2017. Behaviorism. New York. Routledge. https://www.taylorfrancis.com/books/mono/10.4324/9781351314329/behaviorism-john-watson accessed 06 June 2025

Kropt, D. C. 2013. Connectivism: 21th Century's New Learning Theory *European Journal of Open, Distance and e-Learning*, *16*(2). https://files.eric.ed.gov/fulltext/EJ1017519.pdf accessed 2 September 2024

Kuo,Y., Belland, B.R., Kuo, T. 2017. Learning through Blogging: Students' Perspectives in Collaborative Blog-Enhanced Learning Communities. *Journal of Educational Technology & Society*, *20*(2): 37–50. http://www.jstor.org/stable/90002162 accessed 24 September 2024

Madela, N. P. 2016. The impact of university students' perception of mathematics on their curriculum choices: a case study of the University of KwaZulu Natal - Howard College Campus. Durban. University of KwaZulu-Natal. https://researchspace.ukzn.ac.za/items/78bcc3bb-2a20-40ce-a532-e35175498c8d accessed 27 December 2023

Kuran, O. 2023. Closing the Theory-Practice Gap: Socio- Economic Approach and Action Research in Management. *Systemic Practice and Action Research.* https://link.springer.com/article/10.1007/s11213-023-09666-8 accessed 21 May 2024

Maphoso, L. S. T. Mahlo, D. 2014. Basic facilities and academic achievement: A comparative study between boarding and non-boarding schools. *International Journal of Educational Sciences*, *6*(2): 309-315. https://www.tandfonline.com/doi/abs/10.1080/09751122.2014.11890142 accessed 24 January 2024

Matlala, M.E. 2015. The use of the internet by grade 11 learners from selected schools in the Sekhukhune district, Makhuduthamaga local municipality in Limpopo Province. Pietermaritzburg. University Of KwaZulu Natal. https://researchspace.ukzn.ac.za/items/813b1d0f-9b46-4303-b1b9-0c64bc647f92 accessed 23 December 2024

Matope, S. 2022. Learners' views on how the language of learning and Teaching affects their understanding of Mathematical literacy. *International Journal of Science and Research*, *78*(12). http://www.pontejournal.net/mainpanel/abstract.php?TOKEN=gRkgF5411G&PID=PJ-BB3SE accessed 27 December 2023

Mat Noor, M.S.A., & Shafee, A. 2020. The role of critical friends in action research: A framework for design and implementation. *Practitioner Research*, 3: 1-33. https://doi.org/10.32890/pr2021.3 accessed 6 June 2024

Mbonambi, S. M. 2013. An exploration of grade 11 Mathematical Literacy learners' engagement with start-unknown and result-unknown type problems set in a variety of real-life contexts. University of KwaZulu-Natal. https://researchspace.ukzn.ac.za/server/api/core/bitstreams/4dd85e16-0c3f-482e-af1f-394bc8dcea42/content accessed 26 December 2023

Mertler, C. A. 2021 Action Research as Teacher Inquiry: A Viable Strategy for Resolving Problems of Practice. *Practical Assessment, Research, and Evaluation*, *26*(19) https://scholarworks.umass.edu/pare/vol26/iss1/19 accessed 13 April 2024

Mkhize, N. A. 2019. Exploring the role of the Advanced Certificate in Education Mathematical Literacy Programme in developing teacher knowledge of Mathematical Literacy teachers in Umgungundlovu District. Pietermaritzburg. University of KwaZulu-Natal. https://researchspace.ukzn.ac.za/items/eace8691-383b-4466-9dba-b0bacdf2e324 accessed 31 December 2023

Mlilo, T. 2019. Exploring the integration of technology-based tools in intermediate Mathematics classrooms. Pietermaritzburg: University of KwaZulu Natal. https://researchspace.ukzn.ac.za/bitstream/handle/10413/19133/Mlilo_Thobekile_2019.pdf?sequence=1&isAllowed=y accessed 11 August 2023

Mthembu, S. T. 2016. Exploring the use of the IBox when teaching mathematics in selected KwaZulu-Natal secondary schools. Durban. University of KwaZulu-Natal.

https://researchspace.ukzn.ac.za/items/e686bf21-016c-486e-91a2-a10c0c34daec accessed 19 January 2024

Mohammad, Z. 2013. Mixed Method Research: Instruments, Validity, Reliability, and Reporting Findings. *Theory and Practice in Language Studies*, *3*(2), 254-262. https://www.academypublication.com/issues/past/tpls/vol03/02/06.pdf accessed 4 September 2024

Morales, C. Giraldo, R. Torres, M. 2021. Boxplot fences in proficiency testing. Accreditation and Quality Assurance 26, 193–200. https://doi.org/10.1007/s00769-021-01474-8 accessed 17 December 2024

Mshengu, J.G. 2019. Exploring an FET mathematical literacy professional learning community (PLC) as a space that contributes to teacher knowledge. Pietermaritzburg. University of KwaZulu-Natal. https://researchspace.ukzn.ac.za/items/56e8d6de-e196-4e29-998f-33bd3736fda4 accessed 17 May 2024

Muthulakshmi, P., & Veliappan, A. 2016. Effectiveness of an Interactive Multimedia Learning Package in Developing Attitude towards Mathematics. *Journal on School Educational Technology*, *11*(3): 40–46. https://ukzn.idm.oclc.org/login?url=https://www.proquest.com/scholarly-journals/effectiveness-interactive-multimedia-learning/docview/1777884237/se-2?accountid=158225 accessed 5 October 2024

Naidoo, J. 2016. Language matters! Exploring promise's use of pedagogic strategies in her mathematics classroom. *Language Matters*, *47*(3): 372–392. https://doi.org/10.1080/10228195.2016.1233572 accessed 5 October 2024

Ndibomvu, A. P. 2021. The use of information and communication technologies (ICTS) by Grade 11 learners and teachers at public secondary schools within Dr Nkosazana Dlamini Zuma Municipality, KwaZulu-Natal. Pietermaritzburg. University of KwaZulu-Natal. https://researchspace.ukzn.ac.za/items/07620c8b-217a-491f-a3e4-c10d802acd1d accessed 23 May 2024

Ngiba, S. 2020. Examining learners' perceptions of formative assessment in tourism as a subject. Edgewood. University of KwaZulu Natal. https://researchspace.ukzn.ac.za/server/api/core/bitstreams/d6181d4a-8390-44b2-be1c-86d3672fdcf8/content accessed 4 June 2025

Nguse, M. H. 2020. An Exploration of General Education and Training (GET) teachers' mathematical knowledge and its influence on the quality of instruction in the teaching of functions. Pietermaritzburg. University of KwaZulu-Natal. https://researchspace.ukzn.ac.za/items/8abe68df-8cb3-4d8e-8fe3-960638733a89 accessed 30 December 2023

Nyandoro, K. 2019. Language as a Factor Influencing Teaching and Learning Mathematical Literacy at Grade 12 in Moloto Circuit of Limpopo Province. *Unpublished master's thesis*. South Africa. University of South Africa. https://core.ac.uk/download/pdf/328838835.pdf accessed 23 December 2023

Oginni, I. 2018. Home Background and Students Achievement in Mathematics. *Journal of Sociology and Anthropology*, *2*(1): 14-20. https://pubs.sciepub.com/jsa/2/1/3/ accessed 3 October 2024

Pentiah, B. 2023. Online Informal Learning and 21st Century Skills Among Secondary School Students: The Mauritian Context.Edgewood. University of KwaZulu-Natal. https://researchspace.ukzn.ac.za/items/a49243bc-a6fb-419d-9e2d-d51270cee1cf accessed 28 November 2024

Pillay, A. 2013. Enabling student teachers of literature to become agents of change. Durban. University of KwaZulu-Natal. https://researchspace.ukzn.ac.za/items/bc7b1a4a-dd3b-40bb-99e4-b5fb98d5353b accessed 5 July 2024

Reed, R. 2010. From learner algebraic misconceptions to the reflective educator: three cycles of an action research project. Edgewood. University of KwaZulu-Natal. https://researchspace.ukzn.ac.za/items/11fe164f-21e7-4c48-a45e-211a405ac46c accessed 2 June 2024

Riccomini, P. J., Smith, G. W., Hughes, E. M., & Fries, K. M. 2015. The Language of Mathematics: The Importance of Teaching and Learning Mathematical Vocabulary. *Reading & Writing Quarterly, 31*(3): 235–252. https://doi.org/10.1080/10573569.2015.1030995 accessed 5 October 2024

Robertson, S. A. Graven, M. 2020. Language as an including or excluding factor in mathematics teaching and learning. *Math Ed Res J* 32: 77–101. https://doi.org/10.1007/s13394-019-00302 accessed 9 October 2024

Rohid, N. Rusmawati, R. D. 2019. Students' Mathematical Communication Skills (MCS) in Solving Mathematics Problems: A Case in Indonesian Context. *Anatolian Journal of Education*, *4*(2): 19-30. https://files.eric.ed.gov/fulltext/EJ1244446.pdf accessed 12 January 2024

Sa'ad, T. U. Adamu, A. Sadiq, A. M. 2014. The causes of poor performance in mathematics among public senior secondary school students in Azare metropolis of Bauchi State, Nigeria. *Journal of Research & Method in Education*, *4*(6): 32. https://www.researchgate.net/profile/Tata-Saad/publication/284472076_The_Causes_of_Poor_Performance_in_Mathematics_among_Public_Senior_Secondary_School_Students_in_Azare_Metropolis_of_Bauchi_State_Nigeria/links/6299344b55273755ebcd3cee/The-Causes-of-Poor-Performance-in-Mathematics-among-Public-Senior-Secondary-School-Students-in-Azare-Metropolis-of-Bauchi-State-Nigeria.pdf accessed 23 January 2024

Safura, M. 2017. Influence of new curriculum policies on mathematics teachers' work. University of KwaZulu-Natal. https://researchspace.ukzn.ac.za/items/de753d87-cafd-4e78-b6b7-51468d4ddd64 accessed 23 January 2024

Sharma, D. Mahavidhyalaya, M. 2023. Cognitivism and Integration of Technology. *Dr. Shabina Fatima*, 22. https://www.researchgate.net/profile/Shabina-Fatima/publication/382147987_e-book_Methods_of_Improvemnet_in_Teaching_Learning_and_Evaluation/links/668f7466af9e615a15de02f9/e-book-Methods-of-Improvemnet-in-Teaching-Learning-and-Evaluation.pdf#page=2 accessed 6 June 2025

Shepherd, D., L. 2017. Gender, Self-concept and Mathematics and Science Performance of South African Grade 9 Students. Stellenbosch. University of Stellenbosch. www.ekon.sun.ac.za/wpapers/2017/wp112017 accessed 28 January 2024

Siemens, G. 2004. Elearnspace. Connectivism: A learning theory for the digital age. *Elearnspace. org*, 14-16. https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=f87c61b964e32786e06c969fd24f5a7d9426f3b4 accessed 14 August 2024

Silalahi, P. 2017. Exploring students' perceptions of the use of blogs for learning Mathematics at the State Polytechnics Manufacture of Bangka Belitung. *Proceeding International Joint Conference on Science and Technology (IJCST), 1* (1). https://ojs.pnb.ac.id/index.php/Proceedings/article/view/966/768 accessed 23 December 2023

Simangunsong, A.R. Irvan, I. 2023. Analyzing Of Web-Blog Media in Learning Mathematics on Post-Pandemic Covid-19. Jurnal *Tarbiyah*, *30*(1): 64-76. https://jurnaltarbiyah.uinsu.ac.id/index.php/tarbiyah/article/view/2497/1154 accessed 26 January 2024

Siregar, T. M., Frisnoiry, S., Andreani, A. 2020. Blog as a Learning Media in Increasing Student Understanding. *Journal of Physics: Conf. Series*, *1462*(012032): 1-4. https://doi.org/10.1088/1742-6596/1462/1/012032 accessed 2 February 2024

Sutherland, E. 2021. Data Must Fall the Politics of Mobile Telecommunications Tariffs in South Africa. South African Association of Political Studies (SAAPS) 15th Biennial Conference, Rhodes University, 26-28. https://ssrn.com/abstract=2154165 accessed 18 December 2024

Towers, J., Takeuchi, M. A., & Martin, L. C. 2018. Examining contextual influences on students' emotional relationships with mathematics in the early years. *Research in Mathematics Education*, *20*(2), 146–165. https://doi.org/10.1080/14794802.2018.1477058 accessed 5 October 2024

Tsuei, M. 2017. Learning behaviours of low-achieving children's mathematics learning in using of helping tools in a synchronous peer-tutoring system. *Interactive Learning Environments*, *25*(2): 147–161. https://doi-org.ukzn.idm.oclc.org/10.1080/10494820.2016.1276078 accessed 7 June 2024

Tulasi, L., Rao, C. S. 2021. A review of humanistic approach to student centred instruction. *The Review of Contemporary Scientific and Academic Studies*, *1*(1): 1-5. https://www.researchgate.net/profile/Laxmi-Rao-4/publication/359135657_A_Review_of_Humanistic_Approach_to_Student_Centred_Instruction/links/6229ea6897401151d20bd7d2/A-Review-of-Humanistic-Approach-to-Student-Centred-Instruction.pdf accessed 6 June 2025

Turnbull, D. Chugh, R. Luck, J. 2021. Transitioning to E-Learning during the COVID-19 pandemic: How have Higher Education Institutions responded to the challenge? *Education and Information Technologies 26*: 6401–6419. https://doi.org/10.1007/s10639-021-10633-w accessed 4 December 2024

Utecht, J., Keller, D. 2019. Becoming Relevant Again: Applying Connectivism Learning Theory to Today's Classrooms. *Critical Questions in Education*, *10*(2). https://files.eric.ed.gov/fulltext/EJ1219672.pdf accessed 29 August 2024

Vadachalam, N. Chimbo, B. 201). Using Information and Communication Technologies to teach and learn mathematics in South African schools: A snapshot view of its impact. *Africa Education Review*, *14*(1): 212–234. https://doi.org/10.1080/18146627.2016.1224597 accessed 6 October 2024

Visser, M. Jaun, A. Feza, N. 2015. Home and school resources as predictors of mathematics performance in South Africa. *South African Journal of Education, 35* (1): 1-10. https://www.ajol.info/index.php/saje/article/view/113801 accessed 24 December 2023

Walkme. 2023. *Digital Tools*. https://www.walkme.com/glossary/digital-tools/#:~:text=Tools%20%26%20Digital%20Transformation-

,What%20Are%20Digital%20Tools%3F,processes%20and%20overall%20digitization%20efforts accessed 23 August 2023

Wilson Fadiji, A. Reddy, V. 2021. School and individual predictors of mathematics achievement in South Africa: The mediating role of learner aspirations. *African Journal of Research in Mathematics, Science and Technology Education, 25*(1), 65-76. https://journals.co.za/doi/abs/10.1080/18117295.2021.1874687 accessed 12 June 2023

Zakaria, N.A. and Khalid, F., 2016. The benefits and constraints of the use of information and communication technology (ICT) in teaching mathematics. *Creative Education, 7*(11): 1537-1544. https://www.scirp.org/pdf/CE_2016072116354537.pdf accessed 17 January 2024

Zheng, B., Warschauer, M. 2015. Participation, interaction, and academic achievement in an online discussion environment. *Computer & Eduction, 84*: 78-89. https://doi.org/10.1016/j.compedu.2015.01.008 accessed 8 July 2024

Zulu, W. M. 2020. An Exploration of the intergration of technology by mathematics teachers: the case of 10 schools in KwaZulu-Natal under uMlazi District. https://researchspace.ukzn.ac.za/bitstream/handle/10413/19067/Zulu_Mzwandile_Wiseman_2020.pdf?sequence=1&isAllowed=y accessed 11 August 2023

Zuma, S. 2016. Teachers' reflections of teaching Geographical Information System (GIS) at Grade 11 within CAPS in a township school in the uMhlathuze Circuit. Edgewood. University Of KwaZulu-Natal. https://researchspace.ukzn.ac.za/items/6f9f4eb3-9479-4686-89b6-d624290307a6 accessed 3 July 2024

8. APPENDICES

8.1 Appendix 1A Open-ended questionnaire

THORNWOOD SECONDARY MATHEMATICAL LITERACY AND MATHEMATICS BLOG SURVEY

*Please note that learners under the **age of 18** must get permission from a parent/guardian before completing this questionnaire. The information collected on this questionnaire will be used only for research purposes and will be used, and disposed according to the University of KwaZulu Natal ethical clearance policy.*

Instructions for filling in the questionnaire

a) Indicate the most appropriate answers by a tick (√).

b) Where the space is provided, write your answer in it.

c) Please use a pen to answer this questionnaire.

Please select your grade

Grade 09	Grade 10 Mathematics	Grade 10 Mathematical Literacy	Grade 11 Mathematics	Grade 11 Mathematical Literacy

SECTION A: BACKGROUND INFORMATION

1.1 A blog requires ownership of ICT devices and basic knowledge of the internet and social media.

1.1.1 What type(s) of ICTs do you use? (Please select all applicable options)

Cell phone	Personal Computer/ PC /Desktop	Tablet	Laptop

Other (Please Specify)…….

1.1.2 Using a blog requires internet connection, select the method you use to connect to the internet, You may **select more than one** option

Cellular Data	Wi-Fi hotspot (e.g. Public library, mall, etc)	Home Router/ Modem	Hotspot by Friend/Family member

Other …….

1.1.3 I have sufficient knowledge to use the internet and social media?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

1.1.4 I have visited a blog before and have basic understanding of how it works

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

SECTION B: PERCEPTIONS ABOUT THE BLOG

1.2 As part of the study you will learn to create design and run a blog. Blogs can be useful in connecting with friends after school hours and share learning information.

1.2.1 Using a blog in learning mathematics/mathematical literacy is a good idea

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

1.2.2 I think it will be beneficial for me to learn mathematics/mathematical literacy using a blog.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

1.2.3 I am positive about using the blog to learn mathematics/mathematical literacy

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

THANK YOU VERY MUCH FOR YOUR TIME AND PARTICIPATION

8.2 Appendix 1B Closed-ended questionnaire

THORNWOOD SECONDARY MATHEMATICAL LITERACY AND MATHEMATICS BLOG SURVEY

*Please note that learners under the **age of 18** must get permission from a parent/guardian before completing this questionnaire. The information collected on this questionnaire will be used only for research purposes and will be used, and disposed according to the University of KwaZulu Natal ethical clearance policy.*

Instructions for filling in the questionnaire

a) Indicate the most appropriate answers by a tick (√).

b) Where the space is provided, write your answer in it.

c) Please use a pen to answer this questionnaire.

Please select your grade

Grade 09	Grade 10 Mathematics	Grade 10 Mathematical Literacy	Grade 11 Mathematics	Grade 11 Mathematical Literacy

SECTION A: PERCEPTIONS AFTER DESIGNING THE BLOG

1.1 **You learned how to create a blog, including changing colors and themes, updating the blog and commenting on other users' posts.**

1.1 I would like to contribute to sharing knowledge with my classmates through blogs.

.1

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

If you disagree, please explain why?.....

……

……

……

……

1.1 I feel a lot of ideas in my mind to write in the blogs.

.2

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

If you disagree, please explain why?.....……

……

……

……

1.1 I feel that blogs are useful mediums for teaching and learning

.3

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

If you disagree, please explain why?.....……

……

……

……

1.1 I feel the blogs promote collaborative learning

.4

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

If you disagree, please explain why?.....

……

……

……

……

1.1.5 I feel confident in deepening the mathematics/ ML lessons provided using blogs.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

If you disagree, please explain why?.....

……

……..

……

……

SECTION B: EXPIRIENCES AFTER DESIGNING THE BLOG

2.1 I'm skilled in linking other blogs to my blog.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

If you disagree, please explain why?

…….....

……

……..…

……

……..…

2. I’m skilled in organizing lesson material or assignments in my blog

2

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

If you disagree, please explain why?.....

……

……..……

……

……..

2. I am skilled in posting on my blog.

3

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

If you disagree, please explain why?.....

……

…….

……

……..……

2. I’m skilled at making polls or other people’s comments on my blog

4.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

If you disagree, please explain why?.....

……

…….

……

……..…….

2. I’m skilled at creating hyperlinks to websites that can expand my knowledge

5

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

If you disagree, please explain why?.....

……

……

……

……..…….

THANK YOU VERY MUCH FOR YOUR TIME AND PARTICIPATION

8.3 Appendix 2A Focus group interview schedule

1. TOPIC

Interview of learners about the challenges of using the blog to study and learn mathematics/ mathematical literacy.

2. PREPARATIONS

This interview is aimed at finding about challenges that learners have when using the blog. First batch of 10 learners will be randomly taken from grade 9, and the remaining 10 will do the second interview. Five ML learners will be select at random from grade 10 and all 5 learners of mathematics will be interviewed. The second interview will include the five learners of ML who were not selected in the first interview and the same 5 mathematics learners. Grade 11 will follow the same logic with grade 10 because the number of the sample is the same. Note that leading questions must be avoided to avoid biases.

3. INTRODUCTION

Welcome all participants and explain the purpose of the interview.

Establish the ground rules so that a respectful and conducive environment is created

Emphasize confidentiality, the importance of everyone's input, and the right to withdraw from the interview.

Start the interview with the ice-breaker to allow learners to feel comfortable to talk

4. DISCUSSION

Opening question: Can you share your experiences with using the Internet for study, assignments, and examination in mathematics/ML?

Key questions

What are the main challenges you encounter when using this blog?

How do these challenges affect your learning in mathematics/ML?

What support or changes do you think we should provide, add or remove from the blog?

Probing questions

Can you suggest what you would like the blog to include or exclude or fix?

5. CONCLUSIONS

Summary the main points and perform member checking to ensure the data recorded is what exactly what the learners were explaining. Allow learners an opportunity to make comments or ask questions. Thank the participants and close the interview

8.4 Appendix 2B Close-ended questionnaire

THORNWOOD SECONDARY MATHEMATICAL LITERACY AND MATHEMATICS BLOG SURVEY

*Please note that learners under the **age of 18** must get permission from a parent/guardian before completing this questionnaire. The information collected on this questionnaire will be used only for research purposes and will be used, and disposed according to the University of KwaZulu Natal ethical clearance policy.*

Instructions for filling in the questionnaire

a) Indicate the most appropriate answers by a tick (√).

b) Where the space is provided, write your answer in it.

c) Please use a pen to answer this questionnaire.

Please select your Grade

9	10 Mathematics	10 ML	11 Mathematics	11ML

1 **TECHNICAL ISSUES**

1.1 Do you have network reception in your area?

Yes	Sometimes	No

1.2 How is the signal strength in your area?

Strong	Moderate	Weak

2 **REAL-TIME CONNECTION**

2.1 Were you be able to be part of online discussions on the blog?

Yes	Sometimes	No

2.2 Did you participate in the discussions?

Yes	Sometimes	No

2.3 When you were absent from live discussions, did you do a follow up later?

Yes	Sometimes	No

3 **COST OF USING TECHNOLOGY**

3.1 Which method of connection did you use most?

Cellular Data	Wi-Fi	Other

If other, please specify…….

3.2 When using cellular data, which network do you use?

MTN	Vodacom	Cell C	Telkom	Other

If other, please specify……

THANK YOU VERY MUCH FOR YOUR TIME AND PARTICIPATION

8.5 Appendix 3 Informed consent

Informed Consent Document

Dear Participant,

My name is M. Ngidi I am a PhD/ Masters candidate studying at the University of KwaZulu-Natal, Pietermaritzburg Campus. The title of my research is "The use of a blog to improve mathematics and mathematical literacy of grade 9 to 11 learners at Thornwood Secondary School, Pinetown district"

The aim of the study is to explore if the use of the block can improve the results of the learners. And also to explore the perceptions and experiences of learners towards using the blog.

I am interested in distributing a questionnaire to share your perceptions, experiences and challenges on the subject matter.

Please note that:

- The information that you provide will be used for scholarly research only.
- Your participation is entirely voluntary .You have a choice to participate, not to participate or stop participating in the research. You will not be penalized for taking such an action.
- Your views in this questionnaire will be presented anonymously. Neither your name nor identity will be disclosed in any form in the study.

- The records as well as other items associated with the questionnaire will be held in a password-protected computer accessible only to myself. After a period of 5 years, in line with the rules of the university, it will be disposed by shredding and burning.

- If you agree to participate please sign the declaration attached to this statement (a separate sheet will be provided for signatures)

I can be contacted at: School of Social Sciences, University of KwaZulu-Natal, Pietermaritzburg Campus

Email:

Cell:

My supervisor is Dr. Siyanda Kheswa who is located at the School of Social Sciences, Pietermaritzburg Campus / Howard College Campus, Durban of the University of KwaZulu-Natal. Contact details: email Kheswa1@ukzn.ac.za.Phonenumber:033 260 6987

The Humanities and Social Sciences Research Ethics Committee's contact details are as follows: University of KwaZulu-Natal, Research Office, Email: HSSREC@ukzn.ac.za

Thank you for your contribution to this research.

DECLARATION

I…… *(Full names of participant/parent/guardian*) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at anytime should I so desire.I understand the intention of the research.I hereby agree to participate.

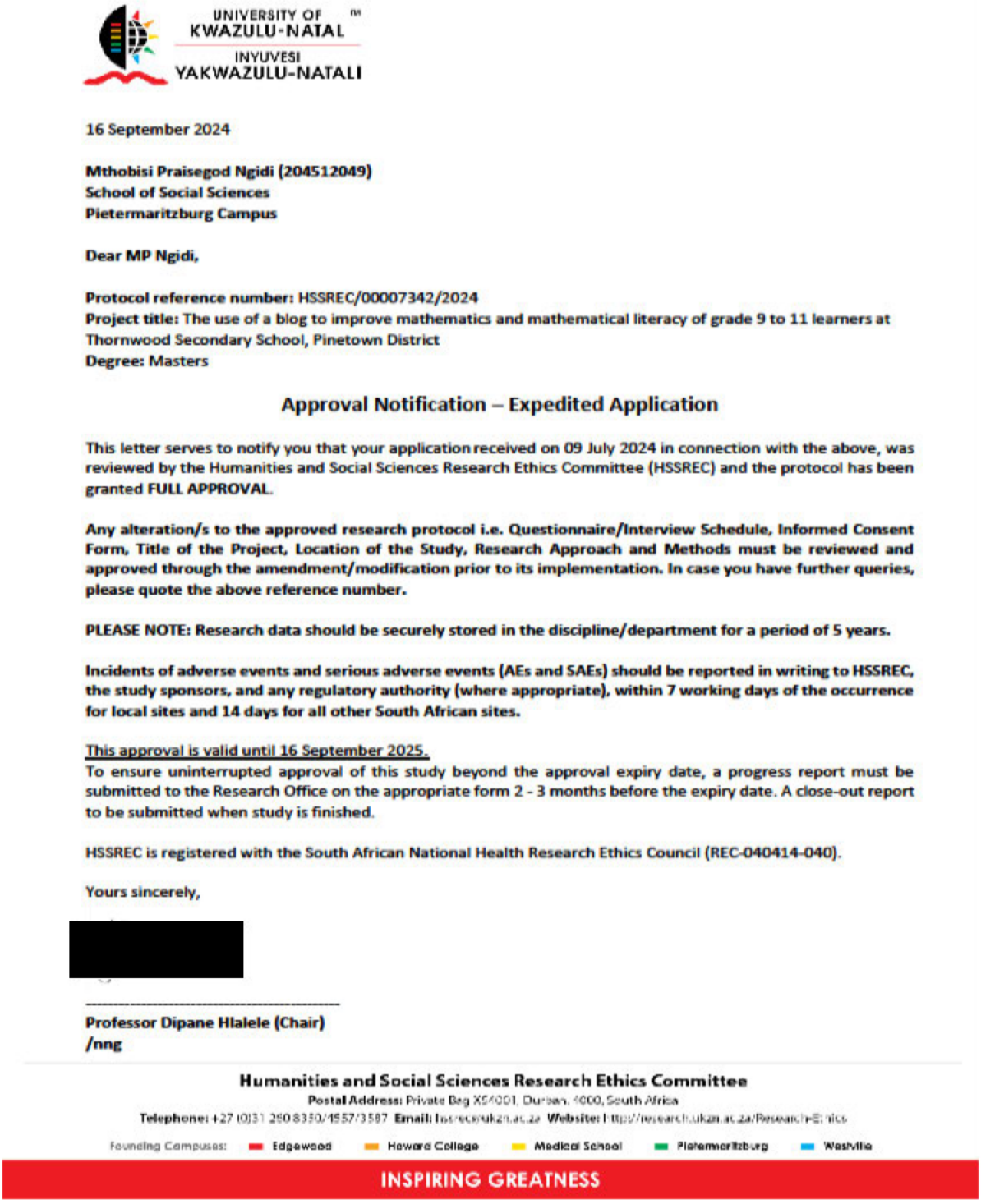
I consent/do not consent to have this interview recorded (if applicable)

SIGNATURE OF PARTICIPANT /PARENT/GUARDIAN

…….

DATE……

8.6 Appendix 4 Ethical clearance



UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

16 September 2024

Mthobisi Praisegod Ngidi (204512049)
School of Social Sciences
Pietermaritzburg Campus

Dear MP Ngidi,

Protocol reference number: HSSREC/00007342/2024
Project title: The use of a blog to improve mathematics and mathematical literacy of grade 9 to 11 learners at Thornwood Secondary School, Pinetown District
Degree: Masters

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 09 July 2024 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

Incidents of adverse events and serious adverse events (AEs and SAEs) should be reported in writing to HSSREC, the study sponsors, and any regulatory authority (where appropriate), within 7 working days of the occurrence for local sites and 14 days for all other South African sites.

This approval is valid until 16 September 2025.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

HSSREC is registered with the South African National Health Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

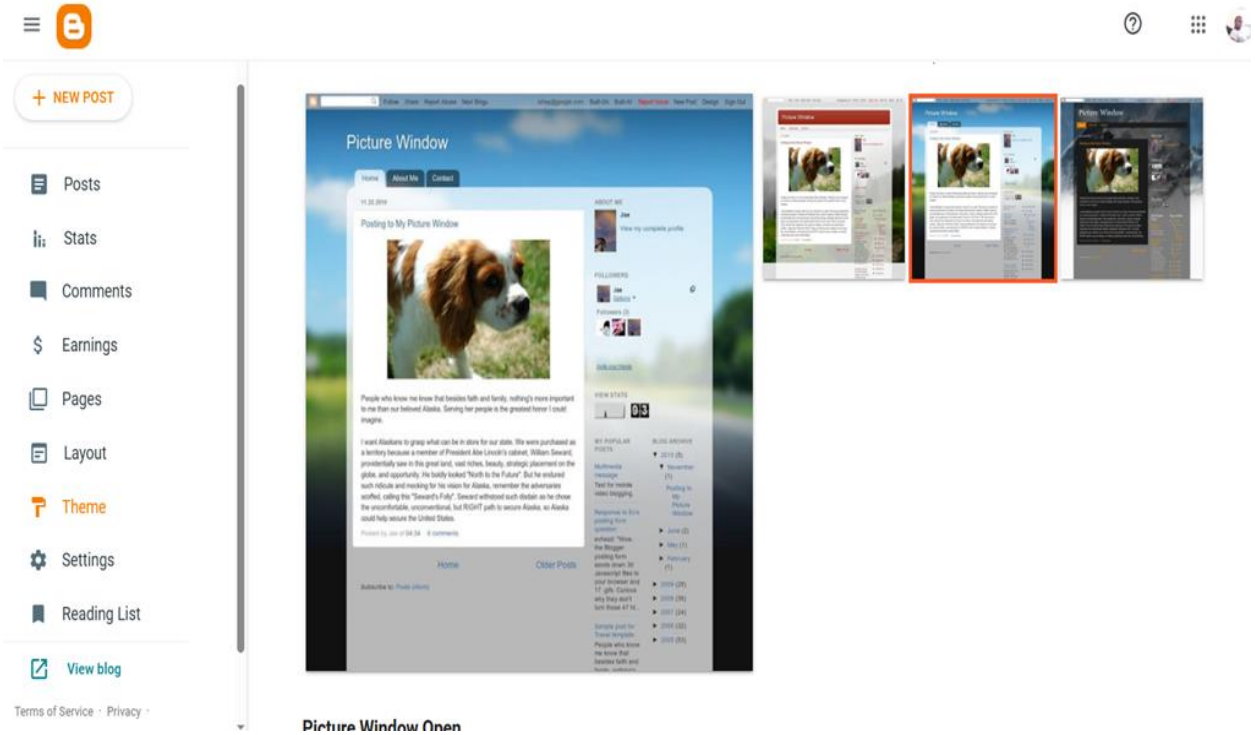
Professor Dipane Hlalele (Chair)
/nng

Humanities and Social Sciences Research Ethics Committee
Postal Address: Private Bag X54001, Durban, 4000, South Africa
Telephone: +27 (0)31 260 8350/1557/3587 **Email:** hssrec@ukzn.ac.za **Website:** http://research.ukzn.ac.za/Research-Ethics

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

INSPIRING GREATNESS

8.7 Appendix 5. A blog screenshot



Picture Window Open