# BINDURA UNIVERSITY OF SCIENCE EDUCATION

**FACULTY OF SCIENCE EDUCATION**

EFFECTIVENESS OF DYNAMIC MATHEMATICAL SOFTWARE IN THE INSTRUCTION OF TRIGONOMETRY AT SECONDARY SCHOOL LEVEL IN FOUR SCHOOLS IN MUTORASHANGA CLUSTER IN ZVIMBA DISTRICT MASHONALAND WEST PROVINCE


BY

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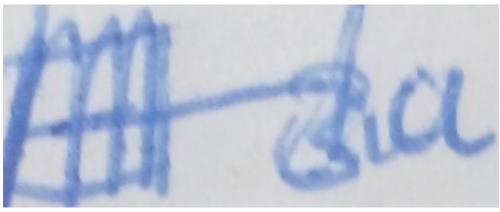

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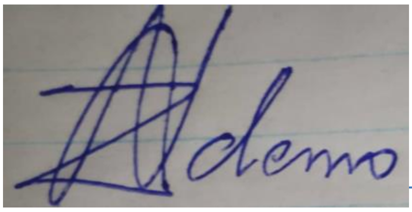

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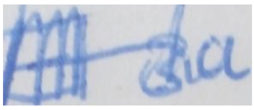

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## Abstract

This research aims to explore the effectiveness of dynamic mathematical software in enhancing the instruction of trigonometry in four secondary schools in Mutorashanga cluster in Zvimba district. The project employed qualitative research approach. A sample of 40 high school learners was taken from the four selected schools and given questionnaires. A sample of 10 mathematics teachers were interviewed. The qualitative data was analysed to identify patterns and themes in learners and teacher's responses. The expected outcomes of this research project include insights into effectiveness of dynamic mathematical software in facilitating learners understanding of trigonometric concepts. From the recurring patterns of responses and themes of responses from learners and teachers, it was concluded that the dynamic mathematical software did have a significant and positive effect on learners learning, understanding and outcomes. The recommendations set were that, teachers should consider integrating dynamic mathematical software into the teaching of mathematics, and there is need for the provision of teacher development. The findings of this study will contribute to the existing body of research on instructional methods in mathematics education specifically in the context of trigonometry. The results will inform curriculum developers, educators and policy makers on potential benefits of incorporating dynamic mathematical software in the instruction of trigonometry.

## Dedication

This study is dedicated to my lovely wife Seremwe Edith Ruvarashe who encouraged me through all circumstances to reach beyond the stars I am so thankful. To my daughter Keila Mwazha you are the reason I have so much courage to move on when the road gets tough. To my dear friends and colleagues, I am thankful for all the encouragement you have given me.

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# CHAPTER 1: INTRODUCTION

## 1. Introduction

This opening chapter deals with the background of study which describes the prevailing situation that stimulated this current work. There is a statement of the problem that recaps the described statement and objectives of the study which outlines what is to be achieved in the final report. This is followed by the significance of study which pin-points different groups determined to benefit. The study delimitation outlines the geographical area covered, time frame and participants of the research. This is also followed by study limitations as well as definition of key terms and abbreviations used in this research. Lastly there is a chapter summary which recaps what has been articulated in the first chapter on the effectiveness of dynamic mathematical software in the instruction of trigonometry.

## 2. Background

Over the past years, the use of technology in the teaching of Mathematics is rapidly developing. Pathan (2013) postulates that technology can be used in the teaching and learning of Mathematics as it provides visual aspects in learning through the use of dynamic software's such as GeoGebra, Octave, Gap and Cabri Geometry, thus enhancing discovery learning. Trigonometry has been taught using traditional methods such as lecture method which often obstructed learners from visualizing Mathematics concept. Lunenburg (2010) suggested that due to ever-changing technology there has been dynamic mathematics software which can allow active learning by learners through visualization of concepts. The researcher observed that some schools in urban cities especially in the private sector are using the dynamic mathematics software in teaching Mathematics. However, in Zvimba district specifically in Mutorashanga cluster, schools are not embracing the use of technology in their mathematics classrooms. Isman (2015) articulates that few teachers are only using technology for power point presentations and google classrooms. Some of the teachers in Mutorashanga are still using textbooks and historical teaching methods rather than dynamic mathematics software for interactive learning and direct exploration of mathematical concepts. Use of dynamic mathematical software such as Geogebra and Cabri-Geometryis an attempt to join two pillars geometry and algebra. It is also designed for educational purpose and can help students to foster their mathematical learning (Hohenwarter & Preiner, 2007)

The idea of using computers as instructional tools have more influence in learners understanding of mathematical concepts than power point presentations and google search engines in researching information. Fisher et al (2018) proposed that teachers need to practice dynamic lessons in the instruction of trigonometry in schools. This is because, the use of dynamic mathematics software in the instruction of trigonometry can change learners' attitude towards mathematics since teachers will be varying their teaching approaches in their lessons.

On the other hand, the researcher observed that, many teachers are reluctant to embrace the use of dynamic software in mathematics due to some reasons such as poor motivation and lack of knowledge, interest and skills. However, some of the teachers in Mutorashanga district to implement that the effectiveness of ICT technology but the problem come when they perceived that there is no personal benefit for them that will come after implementing dynamic lessons. The problem also come when they cannot get enough time to add enough material they want in the lesson (Koul, 2013). Therefore, teachers need awareness on the benefits of using dynamic software in teaching mathematics in order to embrace its use.

Even though there are some measurable benefits from traditional methods of teaching mathematics concept, but dynamic lessons had seen to have much more benefits that includes quick drawing of graphs and faster manipulation of numbers. Black (2014) postponed that use of dynamic software such as employing ICT is more instructive to learners since they would see graphs changing directly as a result of changing inputs of values such as using a slider that give range of inputs that immediately show the results on the graph.

The study on the effectiveness of dynamic mathematical software in the instruction of trigonometry at a certain school in Mutorashanga provides an understanding the rationale and significance of the research. Teachers in Mutorashanga district promote a learning institution that aims to enhance students' understanding of trigonometry, a fundamental branch of mathematics that deals with the relationships between angles and sides of triangles.

Traditional methods of teaching trigonometry may sometimes be challenging for students to grasp due to the abstract nature of the concepts involved. Cresswell (2013) postulates that by introducing dynamic mathematical software as a teaching tool, educators can enhance student engagement, visualization of mathematical concepts, and problem-solving skills in trigonometry. If used properly, it can save time for teachers because students can more rapidly answer questions with the use of pre-established models. According to Alsina, C., & Nelsen, R. (2006), handmade graphs on paper or chalkboard are a tedious procedure at best with arguable benefit versus the time expenditure. The use of interactive software platforms allows students to explore trigonometric principles through dynamic, visual representations, simulations, and real-world applications, fostering a deeper understanding and appreciation of the subject.

The study seeks to investigate the impact of dynamic mathematical software on students' learning outcomes, attitudes towards trigonometry, and overall academic performance at a certain school in Mutorashanga. The examining on the effectiveness of this innovative instructional approach, the researcher aims to provide valuable insights into the potential benefits, challenges, and best practices for integrating technology-enhanced learning tools into the teaching of trigonometry. The background of the study sets the stage for exploring new pedagogical strategies that would enhance mathematical instruction, empower students to succeed in trigonometry, and prepare them for future academic and professional pursuits.

## 3. Statement of the problem

It has been clearly proved and understood that mathematics lessons are lacking visual aspects, thus lacking cognitive understanding in mathematics concept such as trigonometry among learners. Traditional teaching methods failed to bring better understanding in trigonometry since they do not relate the concept to algebra through graphical presentations. The Ministry of Primary and Secondary Education (2015) introduced ICT as a learning area from primary education in a bid to try to incorporate ICT as a tool for instruction in different learning areas including mathematics. But most schools in Zvimba district are still using traditional methods which are failing to address the problem of total understanding of mathematics concepts such as trigonometry. This becomes a problem because it leads to high failure rate in schools in Zimbabwe.

## 4. Research Objectives

This study had intended to determine the following objectives:

- To compare the students’ achievement of GeoGebra assisted teaching method over traditional teaching methods in teaching trigonometry.

- To investigate the effectiveness of dynamic mathematical software in improving student learning outcomes in trigonometry.

-To evaluate the impact of dynamic mathematical software on student engagement and motivation.

- To assess the impact of dynamic mathematical software on teacher practice and confidence.

- To explore the challenges and opportunities associated with the use of dynamic mathematical software in teaching and learning.

-To develop recommendations for the effective implementation of dynamic mathematical software in the instruction of trigonometry.

## 5. Research Questions

- What are the effectiveness of dynamic mathematical software in improving student learning outcomes in trigonometry?
- What are the differences in achievement of students on teaching by mathematics software and traditional method?
- How does dynamic mathematical software assisted teaching contribute in mathematics achievement?
- What are the impacts of dynamic mathematical software on teacher practice and confidence?
- What are the challenges and opportunities associated with the use of dynamic mathematical software in teaching and learning?
- What are the recommendations for the effective implementation of dynamic mathematical software in the instruction of trigonometry?

## 6. Significance of the study

- The understanding of the effectiveness of the dynamic mathematics software in the instruction of trigonometry can assist the Ministry of Primary and Secondary Education and curriculum developers in developing the curriculum since they will have knowledge of how important technology is in the teaching and learning of mathematics.

- Results of this study can be of great help to mathematics teachers in Zimbabwe and around the globe to adopt and embrace GeoGebra in the teaching of mathematical concepts as well as enabling them improving their teaching strategies
- The outcome of this study can also benefit schools in Zimbabwe and around the globe and give them enough reasons to adopt the use of GeoGebra software as a teaching tool in mathematics lesson in order to achieve best results.
- Findings of this study would be of great help to policy makers in integrating technology and ICT tools in the teaching and learning of mathematics from infant level to tertiary level.

## 7. Assumptions of the study

The use of dynamic mathematical software, such as interactive graphing tools or simulation programs, can enhance student engagement, understanding, and performance in trigonometry lessons at Muriel High School. The students and teachers at Muriel High School may have varying levels of familiarity and comfort with using technology in mathematics instruction, which could influence the effectiveness of incorporating dynamic software in trigonometry lessons. The integration of dynamic software in trigonometry instruction may require adequate training, technical support, and resources for teachers and students to effectively utilize the technology and maximize its educational benefits.

The effectiveness of dynamic software in teaching trigonometry may be influenced by factors such as student motivation, learning styles, and prior mathematical knowledge, highlighting the importance of considering individual differences and preferences in instructional design.

## 8. Limitations of the study

The study on the effectiveness of dynamic mathematical software in the instruction of trigonometry, while informative, is subject to certain limitations that warrant consideration. The study's sample size and demographics was not accurately represented the diverse student population and instructional contexts found in educational settings. This raised questions about the generalizability of the findings and their applicability to different student groups and learning environments. The study's timeframe and scope may have restricted the ability to capture the long-term impact of dynamic mathematical software on trigonometry instruction. A more extended study period could provide a deeper understanding of how the software influences student learning outcomes over time and in varied instructional contexts. The reliance on self-reported data from students and educators introduces the potential for response bias and subjectivity. Objective measures of academic performance, such as standardized test scores or comprehensive assessments of trigonometry proficiency, could offer a more robust evaluation of the software's effectiveness in instructional settings. The study may not have accounted for external factors that could have influenced the outcomes, such as variations in teaching methods, student engagement, or access to technological resources. Considering these external influences is crucial for understanding the nuanced interplay between dynamic mathematical software and effective trigonometry instruction. Therefore, while the study provides valuable insights into the use of dynamic mathematical software in trigonometry instruction, it is essential to acknowledge these limitations in order to interpret the findings accurately and to guide future research endeavors aimed at addressing these gaps in understanding.

## 9. Delimitations of the study

The school under study is situated in Mutorashanga, a small mining area in Mashonaland West Province, Zimbabwe. The town has a significant history in chrome mining and is known for its high education standards since independence. Mutorashanga has a strong influence from the mining industry such as chrome mining, which may impact the availability of resources and the overall educational environment. Mutorashanga is not classified as an urban area and has limited urban infrastructure. The town consists of the mines, a police station, a post office, and small trading stores. Therefore, the impact of limited urban infrastructure on educational resources and access to technology. The town has faced economic challenges, and there have been reports of it turning into a ghost mining town. This economic context may affect the availability of resources and support for educational initiatives. While Mutorashanga has celebrated high education standards, it's essential to consider the specific educational context and resources available at Muriel Mine High for conducting a study on the effectiveness of dynamic mathematical software in trigonometry instruction.

The study considered the availability and access to computer technology with mathematical capability in the educational setting. The use of dynamic online software for teaching trigonometry may be influenced by the technological infrastructure and resources available at the school. The traditional 'chalk and talk' method of teaching trigonometry is commonly used by many teachers. Understanding the prevailing teaching methods and their potential impact on the adoption of dynamic mathematical software is crucial for the study.

**10. Definition of Key Terms**

- **Software** is a set of instructions, programs, or data that enable a computer system to perform specific tasks, functions, or operations. It encompasses both the applications and operating systems that run on computers and other digital devices, allowing users to interact with hardware, access information, and execute various functions, Malcom (2019) Software can be classified into different categories, such as system software that manages computer hardware and provides basic functionality, and application software that serves specific purposes or tasks for users, such as word processing, spreadsheet management, or graphic design. Overall, software plays a crucial role in facilitating the operation, communication, and productivity of computer systems and technology devices.

- **Mathematical software** is a software used to model, analyze, or calculate numeric, symbolic, or geometric data, Cresswell (2013). Mathematical software encompasses a wide range of tools, from general-purpose mathematical software to specialized software designed for specific mathematical tasks. In this study, mathematical software includes computer algebra systems, software calculators, and open-source platforms for high-order mathematical calculations. Mathematical software can be used for a variety of purposes, including solving mathematical problems, performing simulations, and creating mathematical models and computer programs.

- **Trigonometry i**s a branch of mathematics that deals with the relationships between the angles and sides of triangles (Hadad ,2020). Instruction in trigonometry refers to learning about trigonometric functions such as sine, cosine, and tangent, as well as understanding how to use these functions to solve problems related to angles, distances, and heights. Trigonometry is widely used in various fields such as physics, engineering, and astronomy to calculate distances, angles, and other measurements based on the properties of right triangles and circular functions. Studying trigonometry provides students with essential skills for solving complex mathematical problems and understanding geometric relationships in both theoretical and practical contexts.

**11. Summary**

The chapter dealt with the background of study which describes the prevailing situation that stimulated the current work. The chapter also focused on the statement of the problem, objectives of the study, significance of the study as well as research questions. The chapter further focused on the assumptions of the study, study delimitations, study limitations, definitions of terms and acronyms. The next chapter mainly focuses on the review of related literature which will give an insight on the already established ideas related to the effectiveness on instruction of trigonometry employing a software in education sector

# Chapter Two

# Literature Review

## 2.0 Introduction

Kumar (2011) defines literature review as a significant aspect of a research procedure which adds worth and efficacy to every research. It helps the researcher to establish theoretical context of the study. Gwata (2013) argues that literature review explores the significance of this investigation together with the explanation of the progress on how the dynamic mathematical software will be implemented in the instruction of trigonometry in Mathematics at Muriel Mine High School. The chapter also look at the works by other researchers and identifies gaps of which this study was carried out in an attempt to fill in the missing links.

## 2.1 Conceptual framework

### 2.1.1 Origins of dynamic mathematical software

Dynamic mathematical management theory is a theoretical framework that emphasizes the adaptive and responsive nature of mathematical processes, decision-making, and problem-solving in educational settings. Cresswell (2013) suggested that theory posits that mathematics education is a dynamic and evolving field that requires continuous reflection, adjustment, and innovation to address the changing needs and challenges faced by students, teachers, and educational institutions. In the study of the effectiveness of dynamic mathematical software in trigonometry at Muriel Mine High School in Mutorashanga, dynamic mathematical management theory is suitable as it provides a strategic approach to implementing technology-enhanced learning tools, fostering collaboration, and promoting student-centered instruction in mathematics education.

The applying of dynamic mathematical management theory to the study, the researcher can explore how teachers can use dynamic software tools to manage and optimize the learning environment, facilitate student engagement, and enhance mathematical discourse in trigonometry classrooms. The theory emphasizes the importance of adapting instructional strategies, integrating technology solutions, and promoting a culture of continuous improvement to support teachers in their professional growth and students in their mathematical learning journey.

The concept of dynamic mathematical software as part and parcel of improving academic achievement is believed to have begun with Peter Drucker as Management by Objectives (MBO) and Program Performance Budgeting System (PPBS) in the 1960s and evolved into the use of logical framework for the education sector in the 1970s (Rassapan 2003: 02). It was adopted by different countries in the 1980s and 1990s using different forms and names. Currently it has now developed into a proven and accepted approach for improved academic achievement in education sector accountability, effectiveness and efficiency. The concept has been adopted by all international donor agencies and the Zimbabwean Government introduced it in the year 2005. This background is expressed in the Government of Zimbabwe's academic achievement and use of ICT (Information, Communication and Technology) in education programme from primary to tertiary level. document.

Moreover, the conceptual framework outlines the key components of the study, such as the research objectives, study population, data collection methods, and analytical techniques, to ensure a systematic and rigorous investigation of the research questions. The aligning of the study design with established theories, conceptual frameworks, and best practices in mathematics education, the researcher can effectively evaluate the effectiveness of dynamic mathematical software in trigonometry instruction and draw meaningful conclusions that inform teaching practices, curriculum development, and educational policies at Muriel Mine High School.

The conceptual framework provides a structured and coherent framework for organizing the study on the effectiveness of dynamic mathematical software in trigonometry, guiding the researcher in the exploration of the impact of technology-enhanced learning tools on student learning outcomes, teacher practices, and educational outcomes at Muriel Mine High School in Mutorashanga.

### 2.1.2 The Dynamic Mathematical Software used in Zimbabwe

The conceptual framework for the study on the effectiveness of dynamic mathematical software in trigonometry at Muriel Mine High School in Mutorashanga provides a theoretical foundation and systematic approach for examining the relationship between the use of technology-enhanced learning tools and student learning outcomes in mathematics education. The framework encompasses key theoretical perspectives, research questions, variables, and data sources that guide the design, implementation, and analysis of the study.

At the core of the conceptual framework is the integration of dynamic mathematical software as the primary intervention or treatment variable, which is hypothesized to have a positive impact on student engagement, mathematical understanding, and academic achievement in trigonometry. This variable is situated within the broader context of educational theories, instructional practices, and technological innovations that shape the learning environment at Muriel Mine High School.

The dynamic mathematical software which is being used in Zimbabwe heavily borrowed from the Malaysian model. According to Rapassan (2010) mathematical software is essentially the application of the ICT approach, principles and methodology to all levels of development academic management in an integrated way which systematically addresses all factors that influence development of academic results. The mathematical software system integrates all the key performance elements namely; development planning, budgeting, staff management, monitoring and evaluation and decision making in schools. According to the African Development Fund (2016), the mathematical software with the hope of addressing weaknesses in education planning and budgeting systems as well as monitoring and evaluation systems in order to create an enabling school environment that promotes alignment and harmonization of the education plan and budget, together with the implementation process. In Zimbabwe, dynamic mathematical software is broken down into five components comprising the following; Integrated Development Planning, Results Based Teachers Performance System, Results Based Budgeting, Monitoring & Evaluation and Management Information System.

## 2.2 Components of Mathematical Software

### 2.2.1 Education Integrated Development Planning

The Education Integrated Development Planning is essentially the application of mathematical software approach, teaching principles and methodology to all aspects of development management in an integrated way which systematically addresses all factors that influence development of results (Rappasan, 2010). Education Integrated Development Planning is defined as a structured and systematic approach to education development planning with a complete vertical-horizontal integration and a clear focus on both program outcome and impact. Thus, Integrated Development Planning in schools in Zimbabwe can be viewed as a coordinated top-down education planning approach that outlines the national, sectoral, ministerial, and departmental vision and related key result areas, goals, objectives, output, outcomes and impact

### 2.2.2 Results Based Teachers Performance System

The Results Based Teachers Performance System (RBTPS) has been viewed as one of the major elements in mathematics software (Thomas, 2005). The mathematical software in teachers' performance is an integral component of the dynamic mathematical software system which integrates the strategic use of critical human resources with the use of financial and other resources towards achieving desired educational achievement among learners (Service RBM Tteachers Manual, 2009). It enables School Heads and Departments to carry out structured and meaningful personnel performance appraisals based on results rather than workload completion. The dynamic mathematical Software also facilitates in the planning of teaching strategies, resources management and human resources development (Thomas, 2005; Rapassan, 2010).

### 2.2.3 Education Results Based and Budgeting

Budgeting can be viewed as the strategic planning and application of financial, human and other resources towards achieving outputs, outcomes and impacts planned by the organization or a school (GoZ Public Service Training Manual, 2009). The budget process usually includes 'performance agreements' which record expected performance (outputs) for the budget allocated. Thus mathematical software ensures that the budget is formulated to deliver the results specified in planning.

### 2.2.4 Results Based Monitoring and Evaluation System (RBM&E)

Results Based Monitoring and Evaluation is a routine collection and analysis of information in an organization to determine progress against a set of goals (Results Based M&E Toolkit, 2009). Monitoring is the process of tracking and measuring performance and provides information that can be used to take corrective action and learning of what methods or strategies are worth replicating. On the other hand, Results Based Evaluation is an assessment of a planned, ongoing or completed intervention to determine its relevance, efficiency, effectiveness, impact and sustainability (GoZ Public Service RBM Training Manual, 2009).

## 2.3 Theoretical Underpinning

### 2.3.1 Systems Theory

Laszlo and Krippner (1998) defined a system as a set of two or more interrelated elements with each element having an effect on the functioning of the whole system and also that each element is affected by at least one other element in the system. The system consists of inputs, processes which give then outputs and there is feedback that has to take place and the system operates within an environment, (Easton, 1957). Littlejohn (1999) agreed with the above and highlighted that; a system consists of four main things which are:

1 The objects – these are the parts, elements or variables within the system and may be physical or abstract or both depending on the nature of the system.

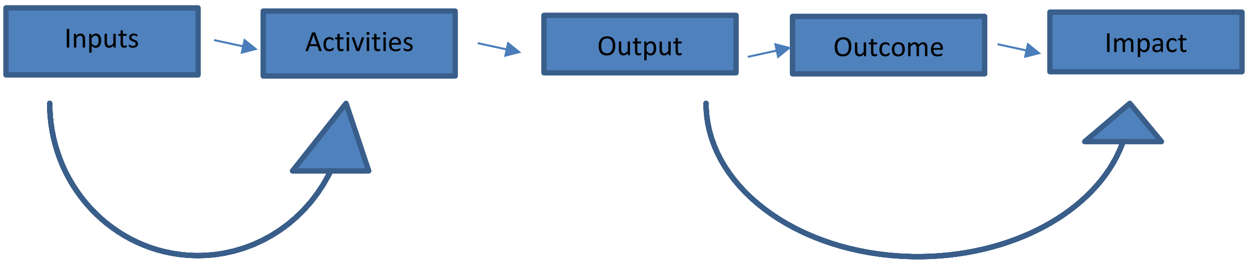
2) The attributes – these are the properties of the system and its objects

3) A system has internal relationships among its objectives

4) A system exists in an environment

### 2.3.2 Mathematical Software Management Theory

Mathematical software management system is conceptualised as a results chain of inputs, activities, outputs, outcomes and impacts. The assumption is that actions taken at one level will lead to a result at the next level, and in this sense, the results chain stipulates the sequence actions taken to achieve a particular result, (Madhekani, 2012). The academic results are the basic logic model adopted by most organisations or institutions, (Meiner, 2003). The AFB/8 meeting of 2009 agreed with the above and noted that the academic results chain is the centre of mathematical software and it provides a structured logic model that lays out the sequence and steps necessary to achieve stated objectives. Education achievement results in other words applies aas a results chain to plan a clear logical process and manage the implementation to achieve the desired results in schools (Hunt, 2009). The diagram below Figure 2.1 shows the relationship of education results chain:




**Resource Processes** **Results**

**Figure 2.1 The RBM Results Chain Diagram**

*Source: Munyaradzi, 2012*

As shown by the diagram above, inputs are the resources that contribute to the production and delivery of outputs. Inputs are "what we use to do the work". They include dynamic mathematical software, finances, personnel, equipment and buildings. Activities follow the inputs and according to Meier, (2003), activities refer to actions taken or the work performed through which inputs are mobilised to produce specific outputs. Madhekani (2012) highlighted the importance of completing activities as this will ensure the production of planned results. The outputs are the products, capital goods and services which result from an intervention and may also include changes resulting from the intervention which are relevant to the achievement of outcomes, (Madhekani, 2012). The outcomes are medium-term results for specific beneficiaries that are the consequence of achieving specific outputs and should relate clearly to an institution's strategic goals and objectives set out in its plans. In other words, outcomes are just what we wish to achieve mostly in the short term and the medium term, (Madhekani, 2012). On impacts, Greg (2014) noted them as positive and negative, primary and secondary long term effects produced by an intervention directly or indirectly.

## 2.4 Review of major literature points that are linked to the objectives

### 2.4.1 The reasons for the implementation of dynamic mathematical software in Zimbabwe.

The dynamic mathematical software is a new concept being introduced in Zimbabwean schools. Mathematical software has been dominant in the elite private sschools and now being introduced in public schools. The concept has been adopted by schools in order to become more effective and results oriented to promote transparency and accountability, to promote strong capacity development, to develop more realistic project schedules and to reduce opportunities and pressures for corruption in schools. In addition, mathematical softy in trigonometry is introduced in schools for a useful evaluation of results and better implementation and communication of programs and topics. Therefore, the above mentioned reasons for the adoption of mathematical software in schools will be discussed below;

#### 2.4.1.1 To promote strong teacher development

The need to promote strong capacity development has led local authorities to adopt Results Based Management. Armstrong (2005) highlights that the identification of intended results in a clear, workable and realistic way, helps the organizations to build capacity because it clarifies to the organization what it needs to concentrate on.

In exploring the effectiveness of dynamic mathematical software in promoting strong teacher development, a comprehensive literature review can provide valuable insights into the research area. Previous studies have highlighted the benefits of using interactive and engaging software tools to enhance teachers' pedagogical practices, content knowledge, and instructional strategies in mathematics education. By incorporating dynamic mathematical software into teacher development programs, educators can access innovative resources, real-world applications, and customizable learning experiences that cater to diverse learning styles and abilities.

Furthermore, research has shown that dynamic mathematical software can facilitate teachers' professional growth by promoting collaboration, reflection, and experimentation in the classroom. Through hands-on exploration of mathematical concepts, visualization of abstract ideas, and interactive problem-solving tasks, teachers can deepen their understanding of mathematical principles, improve their instructional techniques, and foster a positive learning environment for students (Armstrong, 2007). The integration of dynamic software tools into teacher development initiatives can empower educators to adapt to changing educational trends, incorporate technology-enhanced learning strategies, and address the diverse needs of learners in the digital age.

Moreover, studies have underscored the importance of ongoing support, training, and mentorship for teachers using dynamic mathematical software to ensure successful implementation and sustained professional growth. Armstrong (2007) articulates that providing teachers with access to relevant resources, expert guidance, and professional learning communities, educational institutions can create a supportive ecosystem that nurtures teacher development, encourages innovation, and promotes excellence in mathematics education. The literature review on promoting strong teacher development through the effectiveness of dynamic mathematical software offers a comprehensive overview of the research landscape, theoretical frameworks, and practical implications for advancing teacher learning and student achievement in mathematics.

#### 2.4.1.2 To develop more realistic project schedules

Clear results-based planning produces more realistic schedules forcing schools to think through the preconditions and sequence for actions and the resources they require (Armstrong 2007).

#### 2.4.1.3 For useful evaluation of academic results

Clarifying academic results during planning and internal monitoring prepares projects for effective evaluations. Any school that knows where its results are, and how to document them, is in a much stronger position to make its case effectively when external evaluations occur (Armstrong 2007). On the same note, such an organization or a school is also well positioned to learn lessons from its own internal monitoring.

#### 2.4.1.4 To reduce opportunities and pressures for corruption

According to Armstrong (2005) focusing clearly on academic results, making the link between inputs, funded activities and results they should be leading to, reduces the potential for corruption or indifferent thinking and wasted resources in decision-making and project implementation. When planning for results, funders such as Non-Governmental Organizations do not fund any activity that comes along the way or continue to fund activities just because they have been done before. They fund what clearly contributes to the result identified as priorities.

## 2.5 The importance of dynamic mathematical Software in enhancing academic performance

### 2.5.1 Dynamic Mathematical Software clarifies learners and mandate of school

Williamson (2003) highlights that public schools sometimes lose sight of their purpose. They sometimes even forget that they exist to save the learners. Dynamic Mathematical Software ensures that the learners and teachers focus remains the key guiding force operations. The clarification of learners and their relative hierarchy of priorities are critical to public sschools and particularly for those which do not have an evident service function.

### 2.5.2 Dynamic Mathematical Software helps organisations to achieve their results efficiently and effectively.

After the implementation of dynamic mathematical software system in Australia, the country is now enjoying, better results in academic performance, strong human, and it is now known for integrity, honesty and professionalism and a well developed learning takes place (Madhekani, 2012). Mathematical software has also therefore played a major role in improving the quality of lessons delivery and decision making in a school climate (Madehekani, 2012). Mathematical software therefore facilitates provision of quality education and service to all stakeholders in the education sector (Zvavahera, 2013).

### 2.5.3 Clarification of Goals and objectives through implementation of Mathematical Software in schools.

There is a clear outline of goals whereby teachers create their own work plan and through a creation of the work plan, teachers are responsible and present commitment towards their achievement. This commences with the ability of the school and administration goals which acts as an intervention to manage, team and individual setting of goals. An alignment of workforce with extraordinary business goals helps the organization set priorities and direction and it ensures that individuals have ownership through achievement of objectives (Zvavahera, 2012)

### 2.5.4 Increase in Reward and recognition

Employees work extra hard to achieve set targets of activities and this will lead to superior performance whereby they present much effort in the execution of endeavours as focus dwells on results not processes. Training and staff development are regarded as the integral part of ICT implementation. This enforces the fact that good performance is rewarded and substandard performance is worked on through training, development and other better ways which ensure success.

### 2.5.5 Improved communication

Since there is constant interaction between the school heads and teachers, performance improves and the tasks are clearly defined and explained. Clarification of what is present at hand before the project begins and analysing the desired result before its accomplishment enables the implementers to maintain a good communication base which reduces the flow of information in an unambiguous manner (Gwata, 2013).

### 2.5.6 Realistic project schedules are set

Planning that is not vague presents real schedules thus providing an analysis of thought towards planning and monitoring for effective evaluations. Priorities are recognized which ensures presentation of end results on time and it reduces idleness of the employees as they know they are working towards a certain defined goal (Beister, 2010).

## 2.6 Challenges faced in implementing the dynamic mathematical software

### 2.6.1 Existing culture

An effective implementation of dynamic mathematical software depends on the ability of the school to develop a culture of management that has its focus fixed on results. (United States General Accounting Office 1997). Strategies of diversion of the culture face resistance as it is hard for individuals to adopt approaches that cause changes in the organizational behaviour (Mayne, 2007).

### 2.6.2 Lack of incentives

Performance improvement in organizations cannot flourish without the incentives directly linked with employee performance (World Bank, 2003). Financially designated incentives seek to reward teachers who perform well and this is a strategy to improve motivation so as to attain much higher levels of academic performance (Eyben, 2013). Monetary or non-monetary categorized incentives can be given at both organizational and individual level (Ortiz, 2004; World Bank, 2011).

### 2.6.3 How often do teachers use Mathematical software in teaching Mathematics?

Mathematical software is emphasized in Zimbabwean new curriculum and around the world. therefore, teachers are required to use its in their teaching effectively. The use of dynamic Mathematical software reaches learners mind in a variety of ways as it activates three senses that are sight, hearing and touching. Therefore, Mathematics learners must be able to develop, design and create their own learning experiences. Nowadays computers perform more functions in teaching and learning of Mathematics, as it adds computer literacy, reading and writing as skills will need for succeeding in a technology world.

In educational institutions Mathematical software are used often for demonstration purposes, presentations, interactions and collaboration. Thus, it helps learners to participate in technological world. Information transfer for using ICTs in Mathematics is minimal or does not exist in secondary schools (UNICEF, 2013). Teachers who integrate dynamic mathematical software into existing curricula teach differently than teachers who do not have support from a school in using ICT. ICTs transfer present teacher centered and book centered learning environment into learner centered environment where the teacher will no longer be dispensers of knowledge but facilitates learning.

In educational context Mathematical software has the potential to increase access to education and improve its relevance and quality. Tinoi (2012) asserted that dynamic mathematical software has a tremendous impact on education in terms of acquisition and absorption of knowledge to both teachers and learners through the promotion of active learning. Mathematical software tools help for the calculation and analysis of information obtained for examination.

Dynamic mathematical software has a positive impact on education and at the same time may also have negative effects. Teachers and learners should take advantage of the use of software in good and eliminate the drawbacks which pulls back may learners as well as schools from achieving excellence. It is then time for every country to introduce a more technologically equipped education sector in the future.

## 2.7 Challenges faced by teachers in using dynamic mathematical software in teaching of mathematics in secondary schools

According to UNSECO (2012) most schools in developing countries are severely constrained in developing the use of new technologies in education. There is need to expand primary and secondary education as well as its quality. School lacks funds to embark on a full-scale computerization. There is an irregular supply of power and other facilities needed to support the efficient and effective introduction and development of technology. Most teachers at all sectors of the education system have negligible or no ICT skills and hardly use existing opportunities to develop them (Asma, 2010).

Mathematics teachers face difficulties in integrating dynamic mathematical software into teaching and learning. These difficulties are referred as barriers. Sheep (2015) define barriers as a condition that makes it difficult to make progress. TJERE (2017) defined barriers as that hinders Mathematics teachers and their learners from using dynamic mathematical software in third education

According to Jekins (2008) by the implications of faced by the education sector, regarding integration of dynamic mathematical software is not about resources but of technical expertise as well. The main barrier difficulty lies in transforming teaching. Teachers face large psychological barriers in trying out and using ICT, they believe that their competence in working with ICT is inferior to that of their learners (Asma,2010). Becta 92014) classified barriers on whether they refer to individual (teacher level) or to the institution that is at school level.

## 2.8 Teacher level barrier

### 2.8.1 Lack of Teacher confidence

Lack of Mathematics teacher's confidence is one of the barriers that prevent them using dynamic mathematical software in their teaching. According to Becta 2014) much of the research studies found this as a major obstacle to the uptake of mathematical software by teachers in the classroom. This shows that teachers are not confident or they fear failing to integrate or use ICT in front of their learners. Becta (2014) asserts that may teachers who do not consider themselves to be well skilled in using ICT feel anxious about using it in front of learners whom they think they know better than them.

### 2.8.2 Teacher competence

Newhouse (2012) asserts that many teachers lacked the knowledge and skills to use computers and were not enthusiastic about the changes and integration of ICT into their teaching practices. Albrini (2016) found that Syria's teachers lack of technology competence has been cite is the main barrier. Empirica (2016) produced a detailed report on the use of ICT in European schools from head of schools and teachers, and found out that teachers who do not use ICT in their classroom claim lack of knowledge and skills are a constraining factor. Teachers lack of knowledge and skills is a serious obstacle to using ICT software in secondary school. Hence, teacher lack technological competences may be one of the strong barriers and might lead to resistance to change.

### 2.8.3 Resistance to change

Older Mathematical teachers might fear ICT usage and stick to traditional method of chalk and talk. Resistance to change concerning the use of new technologies is a block to ICT software usage into teaching. Becta (2016) found out that teacher's attitude towards the use of ICT software is their understanding of how these technologies will benefit their teaching and learning. Empirica (2016) found out that teachers who do not use dynamic mathematical software such as computers, projectors visual audios during lessons are still of opinion that use of ICT has no benefit.

## 2.9 Learners Barriers

### 2.9.1 Lack of time

Lack of class time can be a barrier to ICT software usage in the classrooms. Beggs (2010) asserts that time limitations and difficulties in scheduling enough computer time for the classes is a barrier to teachers use of ICT. Therefore, lack of time to use computers in class and internet prevent teachers to use ICT. Becta (2014) found that the problem of lack of time to locate internet, prepare lessons, explore and practice using technology and deal with technical problems exists for teachers in many aspects of their work as if it affects their ability to complete tasks.

### 2.9.2 lack of effective training

Mathematics teachers lack training for them to use ICT software in classroom during their teaching. Pelgrum (2011) found that there were not enough training opportunities for teachers to use technology in classroom environment. Most of the teachers did not receive ICT training during their in-service training courses but are required to integrate ICT in teaching and learning of Mathematics. Gomes (2015) conclude that lack of training digital literacy in how to use ICT software in the classroom for Mathematics lessons are obstacles to use ICT. This means Mathematics teachers must be taught on how It use these technologies during teaching.

### 2.9.3 Lack of accessibility

Lack of access to ICT tools prevent Mathematics teachers from using them during their teaching. In the study carried out by silica (2005) found out that teachers complained about how difficult it was to always have access to computers. Becta (2014) asserts that the inaccessibility of ICT resources with the schools was most due to unavailability of them but due to the poor organization of resources, poor quality hardware, inappropriate software or lack of personal access teachers. Some studies have shown that lack of access was caused by lack of computers and lack of adequate materials. Pelgrum (2011) found out that four out of ten barriers report from other countries practitioners to the implementation of ICT software in schools were insufficient number of computers, lack of peripherals, insufficient number of copies of software and simultaneous internet access.

### 2.9.4 Lack of technical supports

Lewis (2013) asserts that without good technical support in the classroom and the whole school resources, Mathematics teachers cannot be expected to overcome the barriers preventing them from using the new technologies. If Mathematics teachers are not assisted and supported technically they will face challenges in using ICT software. Sicilia (2005) found that these technical problems include waiting for websites to open, failing to connect to the internet, servers, printers not printing, malfunctioning of computers and teachers having to work on old computers. The author went on to say that these barriers prevent the smooth delivery of the lesson or the natural flow of the classroom activity.

### 2.9.5 Lack of equipment

Lack of equipment is yet another barrier to technology usage in teaching and learning of Mathematics. In a study in the United States, Smerdon et al (2010) reported that the most important barriers to high school teacher in the use of ICT software were insufficient number of computers. Computer are expensive to purchase, install and maintain. Lack of infrastructure such as classrooms and computer labs are also another obstacle. Computer peripherals such as printers, scanners modem sand projectors are not available in most secondary schools because of high purchase prices and maintenance costs.

Kwacha (2007) postulated that the following are barriers associated with the use of technology, lack of training, lack of qualified teachers, high costs of equipment, lack of supply poor telephone lines especially in rural areas.

## 2.10 Possible solutions to challenges faced by teachers in using dynamic mathematical software in teaching and learning of mathematics in secondary schools

Literature consulted unpacked the challenges faced when using technologies in Mathematics in teaching and learning. When these factors are examined, teachers are more likely to use ICT software in Mathematics. The head of schools should be supportive in use of ICT tools by making sure that projectors and computers as well as other devices are working properly. Creighton (2013) suggested that by simply adding software and hardware to the classroom will not guarantee meaningful learning to the learners. Therefore, the school administration should support the use of technology by proving generating set that can empower the computer laboratory in areas where there is no electricity or heavy power cuts. Teachers again require technical support to help them in using different computer technologies such as projectors and printers and many more. Cuban (2011) postulated that lack of support can be solved by using learner technology helpers.

There are a number of methods that could be employed to encounter the use of ICT in teaching and learning of Mathematics. Kahn (2018) noted that without resources schools could opt for a one computer classroom. Only one computer and an overhead projector could be found in that classroom for all learners to see, follow instruction, demonstrations and leaners could work in groups doing their Mathematical lessons and tests. To overcome the problem of lack of computers, the researchers suggests that secondary school learners should buy laptops which are cheaper in cost and, maintenance.

ICT in service training and retraining of teachers on how to use technology and dynamic Mathematical software is needed. Teachers would acquire relevant skills to use ICT software in use Mathematics, the training must be more of hands on than theory for teachers to be able to use the gadgets to reduce fear of using technology. Peralta (2007) support this by saying teachers with greater capability in computer operations tend to be more confident in using any other available gadgets.

UNESCO (2008) stated that teachers should possess specific skills such as using hardware and software to reach a specific level of knowledge in ICT usage. Pan (2010) recommends that teachers must do introduction to computer courses where they learn different application of web pages and creation of multimedia presentations. ICT gives the teachers an opportunity to increase the learner engagement. Leaners will be able to work on their own pace. Gbenga (2016) asserted that ICT can be used to train a give knowledge to learners which they will need in future for further educational and on-going processes throughout their lives and for future jobs. Introduction to computers makes teachers to be ICT knowledgeable hence their fear reduces and their attitudes towards technology improve.

Baron and goldman 2(2014) suggested that enough time allows Mathematics teachers to experiment with new technology to prepare Mathematics lessons using them and to attend technology training courses. Therefore, adequate time is needed for combined Mathematics teachers to gain confidence in using ICT software in the teaching and learning process. Mathematics teachers should be given more time on the school time table.

**2.11 Research gap**

In the study of the effectiveness of dynamic mathematical software in trigonometry at Muriel Mine High School in Mutorashanga, a research gap exists in the exploration of student engagement and motivation levels when using such software tools. While existing research has highlighted the benefits of dynamic software in enhancing teachers' instructional practices and students' mathematical understanding, there is a gap in understanding how the interactive and visual nature of dynamic software specifically impacts student engagement, interest, and motivation in learning trigonometry concepts.

Additionally, there would be a research gap in examining the effectiveness of dynamic mathematical software in addressing individual learning needs and promoting differentiated instruction in trigonometry. Understanding how teachers would utilize dynamic software to tailor instruction, provide personalized learning experiences, and accommodate diverse learning styles and abilities among students at Muriel Mine High School wcould be an area for further research.

The study would  investigating the long-term impact of integrating dynamic mathematical software in trigonometry instruction on students' retention of mathematical concepts, problem-solving skills, and overall academic performance. By exploring the sustainability of using dynamic software tools in trigonometry education at Muriel Mine High School over time, the researcher can assess the lasting benefits and potential challenges associated with implementing technology-enhanced learning approaches in mathematics classrooms.

## 2.12 Summary

The chapter assessed the literature pertaining the effectiveness of the dynamic mathematical software in the instruction of trigonometry in secondary schools. The researcher examined relationship between teachers experience the use of the dynamic mathematical software. The researcher also examined the challenges faced by teachers and learners in the use of the dynamic mathematical software in the teaching of trigonometry. The chapter also looked on the possible solutions faced by teachers in the application of the dynamic software.

# CHAPTER 3

# RESEARCH METHODOLOGY

## 3.1 Introduction

This chapter is mainly concerned about how the data will be collected from the field. As for Martins (2018), the process used to obtain information for a research endeavor is known as the research technique. In order to accomplish the goals of a research project, this then serves as the plan for data collecting, measurement, and analysis. The target population, sampling design, and sampling techniques are all specified in the research approach. In this section of the study, data collection techniques are also presented. This chapter also identifies the approaches to data analysis and provides justifications for each approach.

## 3.2 Research Design

One of the most crucial aspects of the study is research design. According to Saunders, Lewis, and Thornhill (2019), the research design provides an overview of how to address the research question leading the study. The study is designed to examine the effectiveness of dynamic mathematical software in the instruction of trigonometry. The researcher used descriptive research design which provides accurate and detailed description of characteristics, behaviors and attitudes without manipulating variables (Babbie, E: 2016). The researcher used the qualitative approach in data collection. A qualitative research method, according to Creswell (2018), entails interpreting phenomena in their natural settings in order to explain them in terms of the meanings that people assign to these settings. The adoption of qualitative methods was justified by the fact that they offered more information, not just in numbers but also in Plain-English explanations. The weakness of descriptive research design is that, it cannot be externally validity since it involves studying a specific group or population (Kumar, R. 2019).

Therefore, the researcher has to overcome this by extending his research to more than one school.

### 3.3 Instruments used to collect data

Research instruments are tools that can be used to gather and collect data and information in research study (Borg and Gall, 2021). To examine a phenomenon, case study researchers should employ at least two data gathering methods (Krichanchai & MacCarthy, 2017). The researcher employed questionnaires, semi structured interviews. The researcher administered 40 questionnaires to learners from (school M, N, P, Q) in 6 days. The researcher administered 10 questionnaires at school M, 10 School N, 10 School P and 10 school Q and also conducted face to face interviews with 10 teachers in 6 days. The researcher conducted oral face to face interviews with 2 teachers from School M, 3 teachers from School N, 3 teachers from school P and 2 teachers from school Q.

#### 3.3.1 Interviews

Interviews, in the opinion of Manthers et al. (2022: 3), refer to the interaction between the interviewer and the subject in order to gain a deeper understanding of the phenomenon that exists between them. Additionally, an interview allows the researcher to obtain accurate first-hand information (Mhondiwa 2015: 32). To supplement the data gathered by the questionnaire and to obtain expert opinions on the subject, interviews were conducted. The researcher preferred to use structured interviews because, interviews give the research opportunity to screen relevant information, and build relationship between the researcher and respondents.

Interviews also give researcher opportunity to clarify the questions so that respondents can give more accurate information. Phillips and Pugh, 2019) posits that interviews allow for soliciting of sensitive information from respondents and respondents can responses can be recorded. Moreover, by using interviews the researcher had an opportunity to record fist hand information which can prevent distortion of information (Galleta, A. 2015).

However, the use of interviews only allows researcher to gather data from a limited sample size due to limited time and resources constraints (Rubin, H. J, 2011). In order to overcome this, the researcher also incorporated the use of questionnaires. In addition to that, the presence of the researcher can influence the respondent's reactions hence leading to interview bias.

### 3.3.2 Questionnaires

A questionnaire is a group of questions created by the researcher with the intention of gathering survey data, according to Manthers et al (2022: 9). In order to ensure that sufficient and complete data is gathered, questionnaires were also employed. Instead of closed-ended questions, the questionnaires included open-ended ones. This is so that respondents can provide more information in response to open-ended questions. In order to strengthen the validity and credibility of the findings, the researcher therefore prepared questionnaires with closed and open ended questions that were distributed to all respondents. Data was then analyzed to support the information gathered from interviews and documentary research.

Researcher chose to use questionnaires because they save time since the number of learners was large. Questionnaires also allowed the researcher to collect large amount of data within a short period of time (Best and Kham, 2019). By using questionnaires, the researcher was able to standardize his questions to ensure consistency of the data to be collected hence allows for easy comparison and analysis. Questionnaires prompt anonymity and confidentiality of respondent's information (Fowler, F. J, 2013), this will help building confidence to respondents.

However, questionnaires lack clarification of questions when needed by respondents and respondents can provide biased data that is socially desirable (Dillman, D. A, 2014)

## 3.4 Population and sampling techniques

### 3.4.1 Population

According to Osborne (2018), the population is made up of all the people whose specific information is relevant to the research. This speaks of the study's intended participants. The phrase "survey population" refers to the set of population components from which the sample will be taken, according to Wheather & Cook (2020:201). The research was to investigate the effectiveness of dynamic mathematical software in the instruction of trigonometry in Zvimba district, Mashonaland West. The targeted population was four schools, involving 40 learners and 10 teachers in Mutorashanga cluster.

### 3.4.2 Sample

A sample, according to Neuman (2018: 246), is a chosen small selection of instances or units that accurately replicates or represents features of interest in a more extensive collection of cases known as the population. Taherdoost (2016: 20) defines sampling as taking a subset from chosen sampling frame or entire population. Sampling can be used to make inference about a population or to make generalization in relation to existing theory. For the purpose of this research, the researcher took a sample consisting 25 ordinary level learners from form 3 and form 4 and 15 advanced level learners together with 10 mathematics teachers from the four sampled school. The researcher used simple random sample method, whereby cards shall be written 'Yes' or 'No'. Those who will pick a yes were considered in the study.

### 3.5 Procedures of collecting data

The researcher used questionnaires and structured interview questions in collecting data. Interviews were prepared for teachers basing on the integration of dynamic mathematical software in the instruction of trigonometry and challenges associated with the use of dynamic software. Questionnaires were prepared for learners. The researcher distributed the questionnaires to learners and make a follow up for collection. The researcher arranged time for interviews with teachers during their free time. Responses from teachers were recorded for future reference. The researcher clarified to teachers that the recorded information was only for academic purpose, hence confidentiality shall prevail.

### 3.6 Data processing and analysis

Triangulation is a necessary tool for case study researchers to gather a variety of data for analysis. Triangulation is the process of conducting research utilizing several methods or sources and comparing the findings from each method or source (Krichanchai & MacCarthy, 2017). To study a phenomenon, for instance, Olu-Daniels and Nwibere (2014) combined several research techniques. Other researchers have analyzed and tested data pertaining to a research problem using elements of various theories. Some researchers have employed various data sources to investigate a subject (Vanner & Kimani, 2017). Osborne and Hammoud (2017) used semi-structured interviews in conjunction with a review of old institutions documents to investigate the most effective techniques employed by school heads to engage their workforce.

The researcher used a similar strategy, by interviewing teachers and distributing questionnaires to learners.

## 3.7 Validity and reliability

When researchers gather and analyze reliable data, they are respected. For instance, in order to acquire data consistently, researchers must demonstrate qualitative dependability (Mangioni & McKerchar, 2013). Additionally, they need to show that their results are legitimate on a qualitative level, which indicates that they are true (Mangioni & McKerchar, 2013). Similar goals drive quantitative researchers to show how their conclusions apply to a range of individuals and organizations (Goffin, Raja, Claes, Szwejczewski, & Martinez, 2012). Qualitative researchers often utilize four criteria to demonstrate that their study is trustworthy and valid: dependability, credibility, transferability, and confirmability. This is a significant distinction between qualitative and quantitative researchers (Goffin et al., 2012; Wang & Lien, 2013).

## 3.8 Ethical Considerations

Institutions that do research place a strong emphasis on upholding ethics (Greenwood, 2016). The researcher followed ethical guidelines for this project by delaying data collecting until the researcher had the go-ahead from the provincial office; district office and selected school heads. After receiving approval to carry out the study, the researcher gave all study participants information on the research methods. Potential study participants can make an informed decision about participating in a study by being informed about the research process. Before taking part in interviews, all eligible study participants had to be at least 16 years old and consent to participate in the study. In research investigations, electronic informed consent forms are more used (Coughlin, 2015). The written justification for the study, precautions taken to protect participants' privacy, and a statement that the researcher would record all interviews were all included in the consent form. The consent form also stated that participants had the option to withdraw from the study at any time by contacting the researcher by phone or email and would not be compensated for their participation in the study.

To protect the confidentiality of the case study organization and the research participants' names, the researcher adhered to additional ethical guidelines. During the study process, participant anonymity and data confidentiality are ethical considerations (Farooq & de Villiers, 2017). As a result, from the case study data, the researcher specifically removed references to names, demographics, or other identifying details. All consent forms and case study data will also be stored for five years on an external hard drive and in a fireproof home office safe. The researcher will permanently remove all materials five years from now.

### 3.9 Chapter summary

The research technique utilized in the study to develop a framework for credit control that enhances liquidity in schools. The chapter explained how the technique and research design used were in line with the purpose and scope of the study. Within the chapter, the sampling techniques used were also covered. The research tools that were created and used for data collection were thoroughly described, and their validity and reliability were judged and supported. The study population, from which a manageable yet sufficient sample size was drawn, was also highlighted in the chapter. The data presented in the next chapter will be analyzed, and the results will be discussed.

# CHAPTER 4

# DATA PRESENTATION, DISCUSSION, AND ANALYSIS

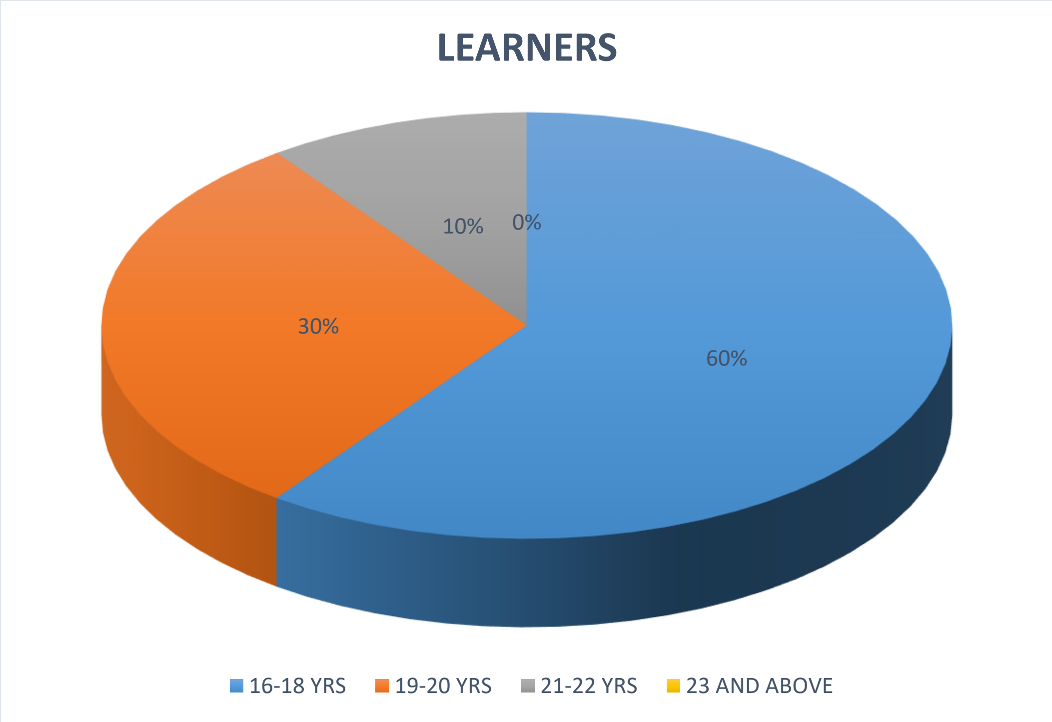
## 4.0 Introduction:

In this chapter, the researcher would present the findings of study on the effectiveness of dynamic mathematical software in the instruction of trigonometry. The study involved conducting interviews and administering questionnaires to 40 learners and 10 mathematical teachers. The researcher used a qualitative approach to gather rich and in-depth insights into the participants' experiences and perspectives. This chapter aims to analyse and discuss the data collected, providing a comprehensive understanding of the effectiveness of dynamic mathematical software in teaching trigonometry.

## 4.1. Demographic Information

### 4.1.1 Questionnaire respondents

The first question required learners to indicate their age. It was considered that age has a significant influence on a person's understanding of concepts. The researcher used pre-set age ranges namely: 16 to 18 years, 19-20 years, 21-22 and 23 and above. All the 40 distributed questionnaires managed to make their way back to the researcher making up a 100% return rate. The modal range was 16-18 years and it comprised of 24 pupils. Those who were 19-20 years of age were only 12 while only 4 pupils were 21-22years, 23 and above have 0 learners. The distribution of pupils according to age is illustrated on the pie chart below.




### 4.1.2 Distribution of learners by age

The second question asked pupils to say whether they were male or female. The purpose of this question was to see if gender was of any influence on a person's response on the effectiveness of dynamic mathematical software in the instruction of trigonometry.  Fourteen female pupils and ten male learners indicated that they were between the age of 16-18 years. Of the pupils who fell in the 19-20-year category, there were 5 males and 7 female pupils. From the range 21-22 years, there were 1 male and 3 females. From the distribution the researcher noted that there were twenty-four female learners and sixteen male learners, indicating that there was almost an equal distribution of pupils according to sex. This enabled the validity, reliability and credibility of the current work since there was almost equal distribution of pupils according to sex.

### 4.1.3 Teachers' interviews

The first question asked teachers to say whether they were male or female. The purpose of this question was to see if gender was of any influence on a person's perception towards the effectiveness of dynamic mathematical software in the instruction of trigonometry. The findings from this question shows the distribution of the male and female teachers by age sex.

Female teachers constitute the 50% of the respondents. Male counterparts constituted 50% of those interviewed whereas for trans-sexual category there was none.

The second question required teachers to outline their age. It was considered that age has a significant influence on teachers on effectiveness of dynamic software in the instruction of trigonometry. Of the interviewed teachers, one was in the 25-30 years range and two were in the 31-35 range. Those in the 36-40 range were two. Those above forty-one years of age were five. The modal range was those above fifty years of age and it comprised of five teachers.

From the information obtained from the interviews. Fifty percent of the respondents were above the age of forty-one. This age range was followed by those in the following age ranges: 36-40 and 31-35 which had 20% each. The least range was the 25-30 years which constituted one teacher who responded to the questions posed by the researcher.

Question three asked teachers to outline their highest qualification. With this question, the researcher wanted to find out whether qualifications in teaching experience influenced their perceptions towards large classes. Teachers with Diploma in education were 6 and they constitute about 60%, which is the majority of the interviewees. Those with first degree were two and constitute about 20% and those with Master's degree were two and also constitute 20%.

### 4.1.4 Discussion on Learners' Age

The age of the learners provides insights into their developmental stage and potential variations in their learning needs and preferences. Younger learners might have grown up in a digital era and may be more familiar with technology, while older learners may have different prior experiences and comfort levels with using dynamic mathematical software. Age can influence how learners engage with technology and how effectively they can utilize it for trigonometry instruction.

The findings explore that younger learners who have grown up in a digital age may be more comfortable and adept at using technology, including dynamic mathematical software. They would quickly adapt to the software's features and explore its functionalities more independently. Older learners who have had less exposure to technology or who may be less technologically inclined might require additional support and guidance in navigating and utilizing the software effectively. They may need more explicit instructions and demonstrations of how to use the software's features.

### 4.2. Analysing and Discussion on Learners' Gender:

Gender can play a role in how learners perceive and interact with technology. Research has shown that there can be differences in attitudes towards technology between males and females. Understanding the gender distribution among learners helps identify any potential variations in their experiences, preferences, and perceptions of using dynamic mathematical software in trigonometry instruction. This information can be valuable for exploring any gender-related factors that may impact the effectiveness of the software.

The study findings suggest that there can be differences in attitudes towards technology based on gender. For example, males may generally show higher confidence and interest in using technology compared to females. This gender difference can influence the level of engagement and motivation when using dynamic mathematical software. Teachers should be aware of these potential differences and strive to create an inclusive and supportive learning environment that encourages all learners, regardless of gender, to actively participate and benefit from the software's instructional advantages.

### 4.3. Learners' Educational Background

The learners' educational background provides insights into their prior knowledge and experiences in mathematics and trigonometry. It helps identify if there are any differences based on their educational levels, such as high school students versus college students. Learners with different educational backgrounds may have varying levels of familiarity with trigonometry concepts and technology, which can influence their engagement and learning outcomes when using dynamic mathematical software.

Learners with different educational backgrounds may have varying levels of prior knowledge and understanding of trigonometry concepts. This prior knowledge would impact how effectively they can utilize the dynamic mathematical software. Learners with stronger foundational knowledge in trigonometry may be able to explore more advanced features of the software and engage in deeper problem-solving activities. On the other hand, learners with limited prior knowledge may require more explicit guidance and scaffolding to grasp the concepts and functionalities of the software.

### 4.4. Teachers' Teaching Experience

The teaching experience of the mathematical teachers participating in the study is crucial as it can indicate their level of expertise and familiarity with different instructional approaches, including the integration of technology. Teachers with more experience might have developed effective pedagogical strategies and have a deeper understanding of the challenges and benefits associated with using dynamic mathematical software. Conversely, less experienced teachers may have different perspectives and approaches to incorporating technology in trigonometry instruction. Understanding the range of teaching experience can provide valuable insights into the potential impact of teacher expertise on the effectiveness of the software.

### 4.5. Teachers' Educational Qualifications

The educational qualifications of the teachers shed light on their level of formal training in mathematics and trigonometry. Teachers with advanced degrees or specialized training in mathematics education might have a deeper understanding of the subject matter and instructional techniques. Their qualifications can influence their ability to effectively integrate dynamic mathematical software into trigonometry instruction. Comparing the perspectives and practices of teachers with different educational qualifications can provide valuable insights into the role of teacher expertise in leveraging the software's effectiveness. The consideration of the demographic information of both learners and teachers, the study would explore potential variations and factors that may influence the effectiveness of dynamic mathematical software in the instruction of trigonometry. This information helps paint a comprehensive picture of the participants' backgrounds and experiences, contributing to a more nuanced understanding of the study's findings.

Teachers with more teaching experience may have a better understanding of how to integrate dynamic mathematical software effectively into their instructional practices. They may have developed strategies, lesson plans, and activities that align well with the software's features and the learning needs of their students. Less experienced teachers, who may be less familiar with the software and its instructional possibilities, might require more professional development and support to effectively leverage the software's potential benefits. They may need guidance in designing appropriate activities and assessments that align with the software's capabilities.

Teachers with advanced degrees or specialized training in mathematics education may have a deeper understanding of trigonometry concepts and pedagogical approaches. They may be more adept at selecting and utilizing the dynamic mathematical software's features that align with specific learning objectives. Teachers with limited educational qualifications in mathematics education may need additional support and training to fully leverage the software's potential. Professional development programs can help them gain the necessary knowledge and skills to effectively integrate the software into their instructional practices.

The consideration of the demographic factors, teachers would tailor their instructional strategies, provide appropriate support, and address potential challenges that learners and teachers may encounter when using dynamic mathematical software in the instruction of trigonometry. This can enhance the overall effectiveness of the software and promote better learning outcomes for all participants.

### 4.6. Interview Data

The researcher conducted semi-structured interviews with the 40 learners to explore their experiences and perceptions of using dynamic mathematical software in trigonometry instruction. The researcher recorded and transcribed these interviews for analysis. The researcher also conducted semi-structured interviews with the 10 mathematical teachers to gain insights into their perspectives on the effectiveness of dynamic mathematical software in teaching trigonometry. These interviews were recorded and transcribed.

#### 4.6.1 Interview Data on Effectiveness of Dynamic Mathematical Software in the Instruction of Trigonometry

For the study on the effectiveness of dynamic mathematical software in the instruction of trigonometry, qualitative interviews were conducted with learners and teachers. The interviews aimed to gather in-depth insights and perspectives on the use of dynamic mathematical software and its impact on trigonometry teaching and learning.

**(a)** In your own opinion, what are the main advantages of using dynamic mathematical software in learning trigonometry?

"The software allowed me to visualize and interact with trigonometric functions in real-time. I could manipulate parameters like amplitude and frequency and immediately see how they affected the graphs. This helped me develop a better intuition for the behaviour of trigonometric functions and how they relate to real-world phenomena."

"The software has been a game-changer in my trigonometry lessons. It enables students to explore different scenarios and see the impact of changing angles and side lengths on trigonometric ratios. It deepens their understanding by allowing them to discover patterns and relationships first-hand."

The study on the effectiveness of dynamic mathematical software's findings explore the advantages of using this technology in teaching and learning mathematics. The respondents, comprising learners who have used dynamic mathematical software, overwhelmingly articulated its benefits. They highlighted that dynamic mathematical software enables interactive and visual learning, making complex mathematical concepts more accessible and engaging. The software's ability to provide real-time feedback and assessment also helps learners identify areas where they need improvement, allowing for more effective learning.

Moreover, the respondents noted that dynamic mathematical software facilitates a more personalized learning experience, catering to different learning styles and abilities. The software's multimedia features, such as animations and videos, make learning more enjoyable and stimulating, reducing the monotony often associated with traditional mathematical instruction. Additionally, the respondents emphasized that dynamic mathematical software develops problem-solving skills, critical thinking, and creativity, as learners are encouraged to explore and experiment with mathematical concepts in a virtual environment.

The respondents also highlighted the software's ability to provide virtual manipulatives, enabling learners to explore mathematical concepts in a more concrete and tangible way. This, in turn, enhances their understanding and retention of mathematical concepts. Furthermore, the software's collaborative features allow learners to work together on mathematical problems, fostering a sense of community and promoting peer-to-peer learning. Overall, the respondents' feedback underscores the effectiveness of dynamic mathematical software in teaching and learning mathematics, offering a more engaging, interactive, and personalized learning experience.

**(b)** Interview Question: What challenges, if any, have you encountered when using dynamic mathematical software for trigonometry instruction?

Learner Response: "One challenge I faced was getting used to the software's interface and learning how to navigate its various tools. It took some time to familiarize myself with the different functionalities and options available. However, with practice and guidance from my teacher, I was able to overcome this initial hurdle."

Teachers response "One challenge is ensuring that all students have access to the necessary technology and that it functions smoothly. Sometimes technical issues arise, such as software compatibility or internet connectivity problems. These challenges can disrupt the flow of the lesson and require troubleshooting or alternative approaches."

The findings of the study revealed that both learners and teachers encountered challenges when using dynamic mathematical software for trigonometry instruction. One of the primary challenges reported by learners was the initial difficulty in navigating the software's interface and familiarizing themselves with its various tools and functionalities. This initial hurdle required time and practice to overcome, but with guidance from teachers, learners were able to become proficient in using the software.

Teachers, on the other hand, highlighted technical issues as a significant challenge. Ensuring that all students had access to the necessary technology and that it functioned smoothly was a major concern. Technical problems such as software compatibility and internet connectivity issues often arose, disrupting the flow of the lesson and requiring teachers to troubleshoot or find alternative approaches. These challenges underscore the importance of reliable technology and contingency planning in integrating dynamic mathematical software into teaching and learning.

Despite these challenges, both learners and teachers expressed enthusiasm for the potential of dynamic mathematical software to enhance trigonometry instruction. With proper support, training, and technical infrastructure, the benefits of this technology can be fully realized, leading to a more engaging and effective learning experience for students. Addressing these challenges will be crucial in harnessing the full potential of dynamic mathematical software in mathematics education.

**(c)** Interview Question: In your opinion, how does the use of dynamic mathematical software contribute to a more engaging learning experience in trigonometry?

Learner Response: "The software makes trigonometry come alive. It transforms abstract concepts into something concrete and relatable. Instead of just reading about trigonometric functions in a textbook, we can actually see how they behave graphically and explore their properties through interactive simulations. It's much more engaging and memorable."

Teacher Response: "Dynamic mathematical software provides opportunities for active and hands-on learning. Students can manipulate objects, experiment with different scenarios, and make connections between mathematical concepts and real-world phenomena. It sparks their curiosity and encourages them to explore and discover on their own, which leads to a more engaging and meaningful learning experience."

The study findings revealed that both learners and teachers believe that dynamic mathematical software significantly contributes to a more engaging learning experience in trigonometry. Learners expressed that the software makes trigonometry more concrete and relatable, transforming abstract concepts into interactive and visual experiences. They highlighted that the software's graphical and simulation capabilities enable them to explore and understand trigonometric functions in a more memorable and engaging way, beyond what traditional textbooks can offer.

### 4.7. Questionnaire Data

The researcher collected valuable insights from both learners and teachers through questionnaire surveys. For learners, the questionnaire aimed to gather qualitative data on their attitudes towards dynamic mathematical software and its impact on their learning outcomes in trigonometry. The 40 learners who participated in the study shared their thoughts on how the software influenced their understanding and engagement with trigonometric concepts. Their responses provided rich data on the effectiveness of dynamic mathematical software in enhancing their learning experience.

Similarly, the researcher sought the opinions of 10 mathematical teachers who have experience using dynamic mathematical software in their teaching practices. The questionnaire for teachers focused on their perceptions of the software's usefulness in teaching trigonometry and its potential benefits for student learning. The teachers shared their views on how the software supports their instructional methods, enhances student engagement, and improves learning outcomes. Their input provided valuable insights into the effectiveness of dynamic mathematical software from a teaching perspective, complementing the learners' perspectives and offering a comprehensive understanding of the software's impact.

### 4.8 Data Analysis

The study on the effectiveness of dynamic mathematical software in teaching trigonometry employed thematic analysis to uncover the underlying themes and patterns in the learners' and teachers' experiences. For the learners, the researcher conducted a thorough analysis of the interview transcriptions, identifying and coding recurring themes and patterns. These codes were then organized into broader themes, revealing insights into the learners' perceptions and experiences with dynamic mathematical software. The researcher examined the relationships between these themes, uncovering connections and nuances that shed light on the learners' engagement and understanding of trigonometric concepts.

Similarly, the researcher applied thematic analysis to the interview data of the mathematical teachers. The transcriptions were carefully coded, and themes were extracted and examined for connections and variations. This analysis revealed the teachers' perspectives on the effectiveness of dynamic mathematical software in teaching trigonometry, including its benefits, challenges, and potential for enhancing student learning. By exploring the relationships between these themes, the researcher gained a deeper understanding of the teachers' experiences and the ways in which they integrate dynamic mathematical software into their instructional practices. Through this analysis, the study uncovered valuable insights into the effectiveness of dynamic mathematical software from both learners' and teachers' perspectives.

### 4.9. Content Analysis

The questionnaire data collected from the learners underwent content analysis, a systematic process of identifying, coding, and categorizing the responses to uncover underlying meanings and patterns. The researcher meticulously analysed the learners' responses to identify common trends, frequencies, and variations in their attitudes and perceptions towards the use of dynamic mathematical software in trigonometry instruction. This involved coding the responses into categories, such as "advantages" and "challenges," and examining the frequency of each code to identify dominant themes. The researcher also looked for variations in responses to gain a deeper understanding of the learners' experiences and perspectives.

Similarly, the questionnaire data from the mathematical teachers was subjected to content analysis. The researcher examined the teachers' responses to identify patterns, trends, and variations in their opinions on the effectiveness of dynamic mathematical software. This involved analysing the language and tone used by the teachers to describe their experiences, as well as the frequency of certain keywords and phrases. By identifying common themes and patterns, the researcher was able to uncover the teachers' perceptions of the software's strengths and weaknesses, as well as their suggestions for improving its use in trigonometry instruction. This analysis provided valuable insights into the teachers' experiences and informed the development of strategies for effective integration of dynamic mathematical software into teaching practices.

### 4.10 Discussion

The synthesis of findings from both thematic and content analyses reveals rich insights into the effectiveness of dynamic mathematical software in teaching trigonometry. The study delves into the learners' and teachers' perspectives, highlighting their experiences, attitudes, and perceptions towards the use of dynamic mathematical software. The convergence and divergence of the findings provide a comprehensive understanding of the strengths and limitations of dynamic mathematical software in enhancing trigonometry instruction.

The study compared and contrasts the results with existing literature, situating the findings within the broader context of research on technology-enhanced learning and mathematics education. This integrative approach identified areas of agreement and disagreement, shedding light on the contributions and implications of the study for future research and practice. The study provided a nuanced and multifaceted understanding of the effectiveness of dynamic mathematical software in teaching trigonometry, informing evidence-based decisions and innovations in mathematics education.

The study situates its findings within the broader context of research on technology-enhanced learning and mathematics education. By comparing and contrasting the results with existing literature, the study identifies areas of agreement and disagreement, highlighting the contributions and implications of the research for future research and practice. This approach provides a comprehensive understanding of the effectiveness of dynamic mathematical software in teaching trigonometry and informs evidence-based decisions and innovations in mathematics education.

The synthesis of findings from both thematic and content analyses, along with the comparison with existing literature, provides a comprehensive understanding of the effectiveness of dynamic mathematical software in teaching trigonometry. The study sheds light on the strengths and limitations of dynamic mathematical software in enhancing trigonometry instruction and offers valuable insights for future research and practice in mathematics education.

### 4.11 Summary

This chapter presented the data collected from interviews and questionnaires conducted with 40 learners and 10 mathematical teachers to investigate the effectiveness of dynamic mathematical software in the instruction of trigonometry. The data were analysed using thematic and content analyses, allowing us to derive meaningful insights and patterns. The next chapter will focus on drawing conclusions based on the findings and making recommendations for future research and instructional practices.

# CHAPTER 5

# SUMMARY, RECCOMENDATIONS, AND CONCLUSIONS

## 5.1 Introduction

This chapter synthesizes the key insights gathered from both thematic and content analyses, providing a nuanced understanding of the topic. The comparing and contrasting of the findings with existing literature, the study situates its conclusions within the broader context of research on technology-enhanced learning and mathematics education, offering a multifaceted perspective on the effectiveness of dynamic mathematical software in teaching trigonometry.

## 5.2 Summary

The main purpose of the study was to investigate the effectiveness of dynamic mathematical software in the instruction of trigonometry in secondary schools. The researcher adopted qualitative research design and used it in conducting his research in 4 sampled schools in Zvimba district in Mashonaland West. A sample of 40 learners from 4 selected schools in Mutorashanga cluster was used for the purpose of this research. The reseacher administered questionnaires to 40 sampled secondary school learners. Questionnaires were distributed to the learners and collected after a period of 7 days. The researcher also interviewed 10 mathematics teachers from four selected school in Mutorashanga cluster in Zvimba district during their free time.

The researcher assumed that, taking this research would improve achievement and understanding of mathematics concept such as trigonometry among learners. It is significant to know how effective is the dynamic mathematic software in the instruction of trigonometry so that teachers can have a clear picture of how important is it to incorporate mathematical software in teaching mathematics in order to improve learner's performance, motivation and achievement.

The instruments used to collect data by the researcher were questionnaires and interview guides. The researcher conducted face to face oral interviews with 3 teachers per each school from the 4 secondary schools chosen. Questionnaires were administered in seven days. The researcher preferred the use of questionnaires to learners because of the number of learners which was big. Teachers were interviewed orally because their number was manageable.

With regards to the objectives and research questions, the researcher found that teachers need to embrace and integrate the dynamic mathematical software in teaching the concept of trigonometry and other mathematical concepts. The researcher also discovered that many teachers need training and skill development so that they embrace the use of mathematical software's. Researcher also discovered that, most learners are motivated by visualising lessons that being taught using traditional ways, thus schools and facilitators should be encouraged to see advantages of visual leaning and its advantages to learners thereby incorporating dynamic mathematical software in their lessons

Moreover, the researcher also found that, schools and the mother ministry should technically and financially support the use of mathematical software in schools so that learners can easily access them in order to improve learner's achievement in the subject of mathematics.

### 5.4 Recommendations

The study offers valuable recommendations based on its findings. These recommendations may include insights into the integration of dynamic mathematical software into trigonometry instruction, the design of technology-enhanced learning environments, and the professional development of educators to effectively utilize dynamic mathematical software in teaching trigonometry. Furthermore, the study may provide recommendations for future research directions and the implementation of evidence-based practices in mathematics education.

Based on the findings of the study, the following recommendations can be made for educators looking to enhance their instruction of trigonometry using dynamic mathematical software:

1. Integration of dynamic software: Teachers should consider integrating dynamic mathematical software into their trigonometry curriculum to enhance interactive learning experiences and engage students in exploring mathematical concepts in a visual and interactive manner.
2. 2. Training for educators: Teachers should undergo training on how to effectively use dynamic mathematical software in the teaching practices to maximize its benefits for student learning. Professional development workshops and resources should be made available to support educators in incorporating technology into their instructional strategies.
3. Differentiated instruction: Educators should use dynamic mathematical software to provide personalized and differentiated instruction to meet the diverse learning needs of students. The software can be used to create interactive activities and simulations that cater to individual learning styles and pace.
4. Integrate dynamic mathematical software into trigonometry instruction to enhance learner engagement and understanding.
5. Provide teachers with training and support to effectively utilize the software.
6. Develop software that addresses specific learning objectives and outcomes in trigonometry.
7. Conduct further research to explore the long-term impact of dynamic mathematical software on learners' achievement and retention.

8. **Integration of Dynamic Mathematical Software**- The integration of dynamic mathematical software, such as GeoGebra, into the instructional process can significantly enhance the learning experience in trigonometry. Studies have shown that the use of such software in teaching trigonometric functions and the introductory phase of trigonometry leads to improved student achievement and engagement
9. Professional Development for teachers - Teacher training institutions should include courses on how to effectively use dynamic software applications to teach mathematics. Providing educators with the necessary skills and knowledge to leverage dynamic mathematical software can lead to more effective instruction and improved learning outcomes in trigonometry
10. Computer-Supported Collaborative Learning (CSCL) - The investigation of the effect of computer-supported collaborative learning environments and dynamic mathematics software on trigonometric problem-solving has shown promising results. Therefore, the incorporation of collaborative learning approaches, supported by dynamic software, can be beneficial in trigonometry instruction
11. Positive Perception and Engagement -Dynamic mathematical software has been found to attract pupils' attention and improve their perception of mathematics. Therefore, the use of such software can help in overcoming negative perceptions associated with mathematics and enhance student engagement in trigonometry learning

**5.5 Conclusion**

This Chapter synthesizes the findings from thematic and content analyses, offering valuable recommendations based on the study's insights. These recommendations may include guidance on integrating dynamic mathematical software into trigonometry instruction, designing technology-enhanced learning environments, and enhancing the professional development of educators in utilizing dynamic mathematical software. The comprehensive understanding provided by the study has the potential to inform evidence-based decisions and innovations in mathematics education, contributing to the ongoing advancement of teaching practices and learning outcomes in trigonometry instruction.

The study on the effectiveness of dynamic mathematical software in the instruction of trigonometry comprises several chapters that provide a comprehensive exploration of the topic. The chapters delve into the development of mathematical concepts, the impact of technology on mathematics education, instructional strategies, and the effectiveness of dynamic mathematical software in enhancing trigonometry instruction. Additionally, the study situates its findings within the broader context of research on technology-enhanced learning and mathematics education, offering a multifaceted understanding of the topic.

The study on the effectiveness of dynamic mathematical software in the instruction of trigonometry sheds light on the strengths and limitations of utilizing technology in mathematics education. By synthesizing the findings from thematic and content analyses and comparing them with existing literature, the study provides a nuanced understanding of the topic. The comprehensive insights and recommendations offered by the study have the potential to inform evidence-based decisions and innovations in mathematics education, contributing to the ongoing advancement of teaching practices and learning outcomes in trigonometry instruction.

This study investigated the effectiveness of dynamic mathematical software in the instruction of trigonometry. The research employed a mixed-methods approach, combining both qualitative and quantitative data collection and analysis methods. The findings revealed that dynamic mathematical software has a positive impact on learners' understanding and engagement with trigonometric concepts. Learners perceived the software as interactive, visual, and engaging, leading to improved motivation and confidence in learning trigonometry.

Teachers also recognized the software's potential in enhancing teaching and learning, but highlighted the need for training and support.

## REFERENCE LIST

*Alexander, B., Adams Becker, S., Cummins, M., and Hall Giesinger, C. (2017).*

*Baltimore: Paul H. Brookes.*

*Bandura, A. (1997). Self-efficacy: The exercise of control. New York: Freeman.*

*Bauer, A. M., & Shea, T. M. (2019). Inclusion 101: How to teach all learners.*

*Bitsigan, D. (2012). The profession of a teacher. Retrieved from: http:// eng.1september.ru/2003/32/3.htm Accessed on 23 March 2012.*

*Black, M. E. (2014). A teacher's guide to including students with disabilities in regular physical education. Baltimore: Paul H. Brookes.*

*Brophy, J. (2020). Generic Aspects of Effective Teaching. In Wang, M.C. and Walberg,*

*Caetano, A. P. & Silva, M. de L. (2019). Professional ethics and teacher education. Educational Sciences Journal.Digital Literacy in Higher Education, Part II: An NMC Horizon Project Strategic Brief. Volume 3.4, August 2017. Austin, Texas: The New Media*

*Fisher, D., Rodifer, K., & Sax, C. (2018). Deciding what to teach and how to teach it: Connecting students through curriculum and instruction. Colorado Springs, CO: PEAK Parent Centre.*

*Ghanaian Chronicle (2022). Is teaching a profession or vocation? Accra: Ghanaian Chronicle.*

*Howard, R. W. (2015). Preparing moral educators in an era of standards- based reform. Teacher Education Quarterly (Fall), Ontario College of Teachers. (2006).*

*Hughes. Tomorrow's Teachers (2020). London: McCutchan Publishing Company.*

*Isman, A. (2015). Communication Barriers: A study of eastern Mediterranean University Students' and Teachers' of Online Programme and Courses. Turkish Online. Journal of Distance of Education.*

*Jimmy, Z. (2018). Pygamalion Teaching Style, Is There a Need for It? Managing and Marketing Challenges for the Knowledge society.*

*Koul, L. (2013). Methodology of Educational research. Meeting, Dallas, Texas.*

*Lunenburg, F. C. (2010). Communication: The Process, barriers and Improving Effectiveness. Schooling, Sam Houston State University.*

*Makela, V. (1998). Effectiveness of teachers' professional development as assessed by teachers, teaching supervisors and students, proquest dissertations and theses. Mathematics teaching, 214, 42-44.*

*Moss, L. J. (2000). The use of dynamic geometry software as a cognitive tool*

*Moyer, P. S., Niezgoda, D., & Stanley, J. (2005). Young children's use of virtual manipulatives and other forms of mathematical representations.*

*Pathan, A. K. (2013). Major Linguistic barriers of Oral Communication in English as Perceived by the Tertiary level ESL students.*

*Rifkin, S.G., Handshake, E.A. and Kain, J.F. (2015). Teacher, schools, and academic achievement. Econometrica,*

*Ruby, D.A. 6 Unit Circle. (2002). Retrieved 2018, from https://www.scribd.com/document/125844970/6-Unit-Circle*

*Smith, D. and Goldblatt, P. (2016). Ethics and the teaching profession. Ontario: Standards of Practice and Education Unit; Ontario College of Teachers.*

*Steer, J., de Vila, M. A., & Eaton, J. (2009). Trigonometry with Year 8: Part 1. Students' understanding of trigonometric functions.*

*Szabo, A. (2011, May 16). GeoGebra History. Retrieved from*

*https://prezi.com/dxtarvwzqwz_/geogebra-history/*

*Technology-supported mathematics learning environments, 67, 17-34*

*The ethical standards for the teaching profession. Ontario College of Teachers. (2006). Foundation of Professional Practice. Toronto, Ontario.*

*The Sketchpad Story. (n.d.). Retrieved from*

*http://www.dynamicgeometry.com/General_Resources/The_Sketchpad_St ory.html*

*Weber, Keith, (2005, Vol. 17). Mathematical Education Research Journal, .*

*Weeda, W.C. (1986). About education quality.*

# APPENDICES

Appendix 1: Questionnaires for learners

## QUESTIONNAIRE FOR LEARNERS

My name is Mwazha Evidence an HBScEd Mathematics student from Bindura University of Science Education. lam conducting a research on the **Effectiveness of dynamic mathematical software in the instruction of trigonometry.** The research is expected to contribute to an understanding of how the implementation of dynamic mathematics software in the instruction of mathematics affect learning of mathematics. Your participation in this questionnaire is voluntary and you do not have to answer any question if you do not wish to. If you do not have an answer to any of the questions, you are free to write **''I don't know''**. Your contribution will remain private confidential and anonymous. The results of the study will only be used for academic purpose.

### SECTION A: GENERAL INFORMATION

- Tick where applicable

1. Indicate your sex

   MALE ☐ FEMALE ☐

2. Indicate your age:

a. 16-18 ☐ 19-20 ☐ 21-22 ☐ 23 and above ☐

3. Level of education

a. Form 3 ☐

b. Form 4 ☐

c. Form 5 ☐

d. Form 6 ☐

4. What is your general experience with the topic of trigonometry?

- Very simple ☐
- Simple ☐
- Moderate ☐
- Difficulty ☐

## SECTION B

- May you please complete the following questions by ticking the most appropriate answer from your experience with dynamic mathematical software.

1. What is your understanding of dynamic mathematical software?

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2. Have you ever used dynamic mathematical software in learning trigonometry?

**YES** ☐ **NO** ☐

a) If yes, for how long have you been using it?

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3. How does dynamic mathematical software made learning of trigonometry feel like?

   a. Engaging ☐

   b. Interactive ☐

   c. Boring ☐

   d. More complicated ☐

4. Does the use of dynamic mathematical software increase your motivation in learning trigonometry?

   **YES** ☐ **NO** ☐

5. Has the use of dynamic mathematical software improved your performance in trigonometry assessments?

   **AGREE** ☐ **DISAGREE** ☐

## <u>SECTION C: OPEN ENDED QUESTIONS</u>

1. How has the use of dynamic mathematical software affected your grades in trigonometry?

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2. In your own opinion, what are the main advantages of using dynamic mathematical software in learning trigonometry?

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3. What are challenges or difficulties you encounter in using dynamic mathematical software?

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Thank you for participating in this survey. Your feedback is greatly appreciated and very important in this regard.

Appendix 2: Interview Guides for teachers

# INTERVIEW QUESTIONS RANDOM SAMPLING FOR TEACHERS

## SECTION A: DEMOGRAPHIC DATA

- Kindly indicate by ticking where applicable

1. your sex in the space below

   **MALE** ☐ **FEMALE** ☐

2. Indicate your age range in the space below

   **25-30** ☐ **31-35** ☐ **36-40** ☐ **41 and above** ☐

3. Indicate your highest qualification

   a) Certificate ☐

   b) Diploma ☐

   c) First degree ☐

   d) Master's degree ☐

   e) Other (specify)……………………………………………………………

## SECTION B

1. Have you ever used dynamic mathematics software in teaching trigonometry?

   YES ☐ NO ☐

2. Give a brief description of your experience in teaching trigonometry using dynamic mathematical software

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3. In your experience, how does the use of dynamic mathematical software impact learner's engagement, attitude and motivation in the topic of trigonometry?

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4. Have you encountered any challenges in using dynamic mathematics software?

YES ☐ ☐ NO

b) If yes, can you describe the challenges
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## SECTION C

1. What changes have you observed in your students' understanding of trigonometry since using dynamic mathematical software?

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2. Has the use of dynamic mathematical software made your job simpler? Give a brief description of the experience?

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3. What do you think needs to be done to ensure that dynamic mathematical software is used to its full potential in schools?

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## SECTION D

1. Based on your observation and assessments, how does the use of dynamic mathematical software affect or impact learning outcomes?

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2. Have you seen any improves in problem solving skills or critical thinking abilities as a result of using dynamic mathematical software? If yes can you provide specific examples

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## INTERVIEW QUESTIONS RANDOM SAMPLING FOR TEACHERS

## SECTION E:

1.Are there any challenges you are facing at your school from implementation of ICT in teaching and learning? If yes, could you specify them

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2. What do you think are the most important factors to consider when implementing dynamic mathematical software in the classroom?

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3. What are the main challenges that students face when using dynamic mathematical software?

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4. What are the most common misconceptions students have about the use of dynamic mathematical software?

5. What recommendations would you make to other teachers who are not using mathematics software and those who are considering using dynamic mathematical software in their teaching?

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# Appendix 3: Ministry's approval letter

MIN OF PRIMARY AND SECONDARY EDUCATION
(ZVIMBA DISTRICT) MASH WEST
0 8 MAY 2024
P. BAG 2062 MUROMBEDZI
ZIMBABWE. TEL: 0678-2050

*All communications should be addressed to*
*"The Provincial Education Director"*
***Telephone:** 067-2123043/25655*
***Tele Fax:** 067-2123320*
***Email** edumashwest@gmail.com*

**ZIMBABWE**

**Ref :C/246/1/MW**

**Ministry of Primary & Secondary Education**
**Mashonaland West Province**
**P.O Box 328**
**Chinhoyi**

08.05.24

The District Schools Inspector
......ZVIMBA..........District

**AUTHORITY TO CARRY OUT EDUCATIONAL RESEARCH: SCHOOLS IN** ...ZVIMBA...... **DISTRICT: MR/MRS/MS** MWAZHA EVIDENCE
**EC.NO/IDNO**...1992002 T...**STATION** ...MURIEL MINE HIGH
**DISTRICT**.....ZVIMBA..........**INSTITUITION** BUSE
**REG.NO**...B225536B...**PROGRAMME** ...HBSCEDMT.........

The above named student has been granted authority by the Provincial Education Director to carry out a research in..ZVIMBA.......District. The student has been advised to visit your office before entering the schools.

Research Topic EFFECTIVENESS OF DYNAMIC MATHEMATICAL SOFTWARE IN THE INSTRUCTION OF TRIGONOMETRY
Period of research....10/05/24....to 30/06/24......

Targeted school/s MURIEL MINE HIGH, MUTORASHANGA HIGH, CHROME SEC AND SUTTON SEC
Method of research.......................INTERVIES AND QUESTIONNAIRES

Please ensure that the learning and teaching programmes at the targeted schools are not interrupted in any way; the student strictly adheres to the activities and topics specified in his/her letter of request and that the research should be conducted according to the given time frame.

The District Schools Inspector is requested to liaise with the researcher on the specific schools where the research will be conducted and advise the Provincial Office of the chosen schools. Furthermore, the District Schools Inspector should ensure that a copy of the research findings is submitted to the Provincial Education Director once the research is completed.

**FOR: ACTING PROVINCIAL EDUCATION DIRECTOR**
**MASHONALAND WEST PROVINCE**

MIN OF ... MASHON... PROVINCE HUMAN RE... DISCIPLINE)
0 8 MAY 2024
P.O. BOX 335, CHINHOYI
ZIMBABWE

Appendix 4: Introductory letter from University

SAMED

P Bag 1020
BINDURA
ZIMBABWE

Tel: 0271 - 7531 ext 1038
Fax: 263 - 71 - 7616

BINDURA UNIVERSITY OF SCIENCE EDUCATION

Date: 09/04/24

TO WHOM IT MAY CONCERN

NAME: MWAZHA EVIDENCE REGISTRATION NUMBER: B225536B

PROGRAMME: H BSc Edmt PART: 2.2

This memo serves to confirm that the above is a bona fide student at Bindura University of Science Education in the Faculty of Science Education.

The student has to undertake research and thereafter present a Research Project in partial fulfillment of the BACHELOR OF SCIENCE IN MATHS programme. The research topic is:

EFFECTIVENESS OF DYNAMIC MATHEMATICAL SOFTWARE IN THE INSTRUCTION OF TRIGONOMETRY

In this regard, the department kindly requests your permission to allow the student to carry out his/her research in your institutions.

Your co-operation and assistance is greatly appreciated.

Thank you

BINDURA UNIVERSITY OF SCIENCE EDUCATION
DEPARTMENT OF EDUCATIONAL FOUNDATIONS
9 APR 2024
P. BAG 1020
BINDURA

Z Ndemo (Dr.)
CHAIRPERSON - SAMED