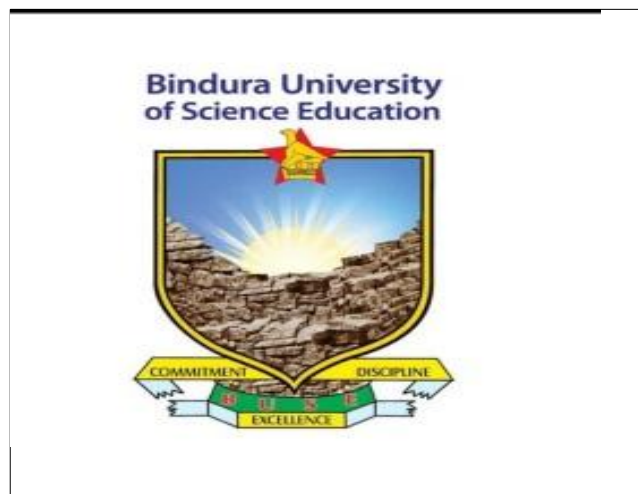


**BINDURA UNIVERSITY OF SCIENCE  
EDUCATION**

**FACULTY OF SCIENCE EDUCATION**

**BACHELOR OF SCIENCE EDUCATION  
HONOURS DEGREE IN MATHEMATICS**



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**Signed**.....

**Date** AUGUST 2025

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Above all, I render my heartfelt gratitude to the Almighty God for his favour and protection. It was not an easy journey but due to his sufficient grace I sailed through.

## **DEDICATION**

This study is dedicated to my lovely wife Thanks Mazana who encouraged me through all circumstances to strive for the best and endure all hardships and my mother Judith Marenga. To my dear friends and colleagues, I am thankful for all the encouragement you have given me. To my dearest son Raphael and my lovely daughter Shimei this project is for you and may it motivate you to strive for the best always using all your abilities putting God first in everything.

## **ABBREVIATIONS / ACRONYMS**

|        |                                                  |
|--------|--------------------------------------------------|
| AI     | Artificial intelligence                          |
| DESMOS | Dynamic Educational Software Made Online Simple  |
| HBSCED | Honours Bachelors Science Education Degree       |
| MoPSE  | Ministry of Primary and Secondary Education      |
| STEM   | Science, Technology, Engineering and Mathematics |

## ABSTRACT

This study explored the opportunities and challenges of using ICT in enhancing conceptual understanding of Quadratic Equations at Ordinary Level. The study was carried at Batanai High School under Rujeko Cluster of Mazowe District. This study investigated the effectiveness of Information and Communication Technology (ICT) in teaching quadratic equations to secondary mathematics. The research employed a mixed-methods approach, integrating both quantitative and qualitative data to provide a comprehensive analysis.

Quantitative data were collected through pre- and post-tests administered to students to measure their understanding and performance in quadratic equations before and after the integration of ICT tools. The tools included software such as Geogebra, interactive whiteboards, and educational apps designed to facilitate the learning of quadratic equations. The quantitative analysis focused on comparing test scores to determine the impact of ICT on students' academic performance.

Qualitative data were gathered through semi-structured interviews and focus group discussions with students and teachers. These interviews explored participants' experiences, perceptions, and attitudes towards the use of ICT in mathematics instruction. The qualitative analysis aimed to identify themes related to student engagement, motivation, and the perceived opportunities and challenges in using ICT in the classroom.

Findings indicated that the use of ICT in teaching quadratic equations significantly enhanced student engagement and motivation. Students reported a better understanding of complex concepts and a more interactive and enjoyable learning experience. Teachers also noted improvements in students' problem-solving skills and overall performance. However, the study also highlighted several challenges, including limited access to technology, insufficient training for teachers, and the need for on-going technical support.

The study concluded with recommendations for educational policy and practice. It advocates for increased investment in ICT resources and infrastructure, as well as comprehensive professional development programs for teachers to effectively integrate technology into their teaching practices. These recommendations aimed to optimize the benefits of ICT in mathematics education and contribute to the overall improvement of educational outcomes in Zimbabwe.

A mixed-methods approach was employed in the study, combining both quantitative and qualitative data collection and analysis methods. The study sampled 50 Form 3 students,

divided into two groups: an ICT-based instruction group and a traditional instruction group. The results showed a significant improvement in students' understanding and retention of quadratic equation concepts in the ICT-based instruction group compared to the traditional instruction group. Furthermore, the study revealed that ICT-based instruction enhanced student engagement, motivation, and collaboration. The findings of this study provide insights into the potential benefits of ICT integration in mathematics education in Zimbabwean secondary schools, and highlight the need for teacher training and infrastructure development to support effective ICT-based instruction.

**Keywords:** ICT integration, quadratic equations, secondary mathematics education, Zimbabwe.

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**Title:** : ICT enabled instruction for the teaching of quadratic equations at Batanai High School, Mazowe, Mashonaland Central Province, Zimbabwe

## CHAPTER ONE: INTRODUCTION TO THE STUDY

### 1.1 Introduction to the study

The use of Information and Communication Technology (ICT) in teaching and learning has become increasingly prevalent in recent years, particularly in the field of mathematics education. The integration of ICT in teaching quadratic equations, a fundamental concept in secondary mathematics, has the potential to enhance students' understanding and engagement with the subject. This study aims to examine the use of ICT in teaching quadratic equations to secondary mathematics students at Batanai High School in Mazowe, Zimbabwe.

The integration of Information and Communication Technology (ICT) in education has become increasingly prevalent in recent years. This study aims to examine the use of ICT in teaching Quadratic equations to Secondary Maths students at Batanai High School in Glendale, Mazowe.

The integration of Information and Communication Technology (ICT) in education has been a subject of interest for researchers, educators, and policymakers for several years. The use of ICT in teaching and learning has been shown to enhance students' engagement, motivation, and learning outcomes. However, the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts is not well-documented in Zimbabwe.

This study aims to investigate the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts at Batanai High School in Glendale, Mazowe District, Mashonaland Central Province, Zimbabwe. The study will provide valuable insights into the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts in Zimbabwe.

The study will contribute to the existing body of knowledge on the use of ICT in teaching and learning mathematics in Zimbabwe. The findings of the study will provide recommendations for the integration of ICT in mathematics education in the country.

The use of Information and Communication Technology (ICT) in teaching and learning has become increasingly prevalent in recent years, particularly in the field of mathematics education. The integration of ICT in teaching quadratic equations, a fundamental concept in secondary mathematics, has the potential to enhance students' understanding and engagement

with the subject. This study aims to examine the use of ICT in teaching quadratic equations to secondary mathematics students at Batanai High School in Mazowe, Zimbabwe.

## **1.2 Background of the study**

The integration of Information and Communication Technology (ICT) in education has been a subject of interest for researchers, educators, and policymakers for several years. The use of ICT in teaching and learning has been shown to enhance students' engagement, motivation, and learning outcomes, Dillenbourg et al. (2005) . However, the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts is not well-documented in Zimbabwe.

Mathematics is a subject that is taught in all levels of education, and it is a subject that is required for students to pass all levels of education. However, many students struggle with mathematics, and this is often due to a lack of understanding of mathematical concepts. The use of ICT in teaching and learning mathematics has been shown to enhance students' understanding of mathematical concepts. However, the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts is not well-documented in Zimbabwe.

In Zimbabwe, the integration of ICT in education is still at its infancy, and there is a lack of research on the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts. The study aims to fill this gap by investigating the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts at Batanai High School in Glendale Mazowe, Mashonaland Central Province, Zimbabwe.

Quadratic equations are a fundamental concept in mathematics that are commonly used in various fields, including science, engineering, and finance. The ability to solve quadratic equations is a critical skill for students to master in order to succeed in their academic and professional pursuits. However, teaching quadratic equations can be challenging, particularly for students who struggle with abstract concepts and mathematical reasoning.

The integration of ICT in teaching mathematics has the potential to address some of these challenges by providing students with interactive and engaging learning experiences. ICT

tools such as computer software, interactive whiteboards, and online resources can be used to present mathematical concepts in a visual and dynamic way, making them more accessible and understandable for students.

Quadratic equations are a fundamental concept in mathematics that are commonly used in various fields, including science, engineering, and finance. The ability to solve quadratic equations is a critical skill for students to master in order to succeed in their academic and professional pursuits. However, teaching quadratic equations can be challenging, particularly for students who struggle with abstract concepts and mathematical reasoning.

The integration of ICT in teaching mathematics has the potential to address some of these challenges by providing students with interactive and engaging learning experiences. ICT tools such as computer software, interactive whiteboards, and online resources can be used to present mathematical concepts in a visual and dynamic way, making them more accessible and understandable for students.

The integration of Information and Communication Technology (ICT) in education has become increasingly important in recent years. As the world becomes more digital, the use of ICT in teaching and learning has become a critical component of education. In the field of mathematics, the use of ICT has the potential to enhance students' learning experiences and improve their understanding of mathematical concepts (Lin & Lin, 2012).

Despite the importance of ICT in education, there is a lack of research on the use of ICT in teaching and learning mathematics in Zimbabwe. This study aims to fill this gap by investigating the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts at Batanai High School in Glendale, Mazowe Mashonaland Central Province, Zimbabwe.

The online mathematics learning platform being studied is a web-based application that provides interactive mathematics lessons and exercises. The platform is designed to provide students with immediate feedback on their work allowing them to identify and correct their mistakes. The platform also provides students with a variety of mathematical problems to solve, ranging from basic arithmetic to more complex algebraic expressions (Jang et al., 2013; Ozguner & Ozguner, 2017; Peker & Calikli, 2017).

The study will focus on a sample of 50 high school students from Batanai High School. The students will be randomly assigned to two groups: a control group and an experimental

group. The control group will continue with their regular mathematics classes, while the experimental group will use the online mathematics learning platform for their mathematics lessons.

The study will use a quasi-experimental design, with pre- and post-tests administered to both groups to measure their understanding of mathematical concepts. The pre-test will be administered at the beginning of the study, while the post-test will be administered at the end of the study. The difference in the scores of the pre-test and post-test will be used to measure the effectiveness of the online mathematics learning platform in enhancing students' understanding of mathematical concepts (Lai & Hwang, 2016; Lin & Lin, 2012).

The study will also gather qualitative data through focus group interviews with students, teachers, and parents to gain a deeper understanding of their experiences and perceptions of using the online mathematics learning platform.

The findings of the study will provide valuable insights into the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts at Batanai High School. The results of the study will also contribute to the existing body of knowledge on the use of ICT in teaching and learning mathematics in Zimbabwe, and provide recommendations for the integration of ICT in mathematics education in the country.

The integration of Information and Communication Technology (ICT) in education has transformed traditional teaching methods, providing innovative ways to enhance learning outcomes. In Zimbabwe, particularly at Batanai High School in the Mashonaland Central Province, the use of ICT in teaching subjects like mathematics, specifically quadratic equations, has the potential to improve student engagement and understanding.

In recent years, the integration of Information and Communication Technology (ICT) in education has become a focal point for enhancing learning outcomes. In Zimbabwe, particularly at Batanai High School located in the Mazowe region of Mashonaland Central Province, the use of ICT in teaching has garnered attention as a means of improving students' comprehension of complex mathematical concepts, including quadratic equations. Quadratic equations are fundamental in mathematics, appearing in various applications across physics, engineering, and economics. Despite their importance, students often struggle to grasp these concepts due to traditional teaching methods that may not engage the digital-savvy youth of today.

The teaching of mathematics in secondary schools has evolved significantly with the advent of Information and Communication Technology (ICT). In Zimbabwe, where the curriculum seeks to accommodate modern pedagogical approaches, the integration of ICT in teaching mathematical concepts, particularly quadratic equations, has gained momentum. Quadratic equations, fundamental in algebra, are crucial for students' understanding of higher-level mathematics and its applications in various fields.

Quadratic equations are an important topic in mathematics, and understanding them is crucial for students to excel in the subject. The use of ICT tools such as interactive software, online resources, and graphing calculators can enhance the teaching and learning of Quadratic equations by providing visual representations, interactive exercises, and real-world applications.

Batanai School is a secondary school located in a rural area, where access to quality education resources may be limited. The use of ICT in teaching quadratic equations can provide students with interactive and visual learning experiences, potentially improving their academic performance in mathematics.

The use of Information and Communication Technology (ICT) in education has been increasing in recent years, and it has the potential to improve the quality of education. In mathematics education, ICT can be used to enhance students' learning experiences and improve their understanding of mathematical concepts. However, there is limited research on the use of ICT in teaching quadratic equations in Zimbabwe.

Quadratic equations are an important topic in secondary mathematics education. They are used in various fields such as physics, engineering, and economics. In recent years, there has been a growing emphasis on using ICT in teaching and learning mathematics. The use of ICT in mathematics education has the potential to enhance students' learning experiences and improve their understanding of mathematical concepts.

In Zimbabwe, the education system has been affected by various challenges such as a shortage of qualified teachers, inadequate resources, and limited access to quality education. The use of ICT in teaching and learning has the potential to address some of these challenges by providing students with access to a wide range of resources and learning materials.

The integration of Information and Communication Technology (ICT) in education has been a subject of interest for researchers, educators, and policymakers for several years. The use of

ICT in teaching and learning has been shown to enhance students' engagement, motivation, and learning outcomes. However, the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts is not well-documented in Zimbabwe.

Mathematics is a subject that is taught in all levels of education, and it is a subject that is required for students to pass all levels of education. However, many students struggle with mathematics, and this is often due to a lack of understanding of mathematical concepts. The use of ICT in teaching and learning mathematics has been shown to enhance students' understanding of mathematical concepts. However, the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts is not well-documented in Zimbabwe.

In Zimbabwe, the integration of ICT in education is still at its infancy, and there is a lack of research on the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts. The study aims to fill this gap by investigating the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts at Batanai High School in Glendale Mazowe Mashonaland Central Province, Zimbabwe.

### 1.3 Purpose of the study

The purpose of this study is to investigate the use of ICT in teaching quadratic equations to secondary mathematics students at Batanai High School in Mazowe, Zimbabwe. The study aims to:

Examine the current practices and approaches used by teachers in integrating ICT in teaching quadratic equations.

Identify the benefits and challenges of using ICT in teaching quadratic equations.

Explore the attitudes and perceptions of secondary mathematics students towards the use of ICT in teaching quadratic equations.

Provide recommendations for effective use of ICT in teaching quadratic equations.

The purpose of this study is to investigate the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts at Batanai High School in Glendale Mazowe Mashonaland Central Province, Zimbabwe. The study

aims to fill the gap in the existing literature on the use of ICT in teaching and learning mathematics in Zimbabwe.

The online mathematics learning platform being studied is a web-based application that provides interactive mathematics lessons and exercises. The platform is designed to provide students with immediate feedback on their allowing them to identify and correct their mistakes. The platform also provides students with a variety of mathematical problems to solve, ranging from basic arithmetic to more complex algebraic expressions (Jang et al., 2013; Ozguner & Ozguner, 2017; Peker & Calikli, 2017).

The study will focus on a sample of 50 high school students from Batanai High School. The students will be randomly assigned to two groups: a control group and an experimental group. The control group will continue with their regular mathematics classes, while the experimental group will use the online mathematics learning platform for their mathematics lessons.

The study will use a quasi-experimental design, with pre- and post-tests administered to both groups to measure their understanding of mathematical concepts. The pre-test will be administered at the beginning of the study, while the post-test will be administered at the end of the study. The difference in the scores of the pre-test and post-test will be used to measure the effectiveness of the online mathematics learning platform in enhancing students' understanding of mathematical concepts (Lai & Hwang, 2016; Lin & Lin, 2012).

The study will also gather qualitative data through focus group interviews with students, teachers, and parents to gain a deeper understanding of their experiences and perceptions of using the online mathematics learning platform.

The findings of the study will provide valuable insights into the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts at Batanai High School. The results of the study will also contribute to the existing body of knowledge on the use of ICT in teaching and learning mathematics in Zimbabwe, and provide recommendations for the integration of ICT in mathematics education in the country.

The purpose of this study is to investigate how the use of ICT can improve the teaching and learning of Quadratic equations at Batanai High School. By examining the effectiveness of

ICT tools in the classroom, this study aims to provide insights into best practices for integrating technology in mathematics education.

The purpose of this study is to investigate the effectiveness of using ICT tools in teaching quadratic equations to Secondary Maths students at Batanai High School. By examining the impact of ICT on students' learning outcomes and engagement with the subject, this study aims to provide insights into the potential benefits of integrating technology in mathematics education.

The study aims to investigate the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts at Batanai High School in Glendale Mazowe Mashonaland Central Province, Zimbabwe. The study will provide valuable insights into the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts in Zimbabwe.

The study will contribute to the existing body of knowledge on the use of ICT in teaching and learning mathematics in Zimbabwe. The findings of the study will provide recommendations for the integration of ICT in mathematics education in the country.

The study will also provide valuable insights into the experiences and perceptions of students, teachers, and parents in using the online mathematics learning platform. The qualitative data gathered through focus group interviews will provide a deeper understanding of the challenges and opportunities of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts.

The findings of the study will inform the development of effective strategies for integrating ICT in mathematics education in Zimbabwe. The recommendations of the study will provide guidance for educators, policymakers, and educational institutions in the country.

The purpose of this study is to investigate the use of ICT in teaching quadratic equations to secondary mathematics students at Batanai High School in Mazowe, Zimbabwe. The study aims to:

Examine the current practices and approaches used by teachers in integrating ICT in teaching quadratic equations.

Identify the benefits and challenges of using ICT in teaching quadratic equations.

Explore the attitudes and perceptions of secondary mathematics students towards the use of ICT in teaching quadratic equations.

Provide recommendations for effective use of ICT in teaching quadratic equations.

The purpose of this study is to investigate the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts at Batanai High School in Glendale Mazowe Mashonaland Central Province, Zimbabwe. The study aims to provide valuable insights into the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts in Zimbabwe.

The study will contribute to the existing body of knowledge on the use of ICT in teaching and learning mathematics in Zimbabwe. The findings of the study will provide recommendations for the integration of ICT in mathematics education in the country.

#### **1.4 Statement of the problem**

Despite the potential benefits of using ICT in teaching quadratic equations, there is a lack of research on the current practices and approaches used by teachers in integrating ICT in teaching quadratic equations in Zimbabwe. Additionally, there is limited understanding of the attitudes and perceptions of secondary mathematics students towards the use of ICT in teaching quadratic equations. This study aims to address these gaps in knowledge by providing a comprehensive examination of the use of ICT in teaching quadratic equations at Batanai High School.

Despite the increasing availability of ICT in education, there is a lack of research on the use of ICT in teaching and learning mathematics in Zimbabwe. This is a significant problem as the use of ICT in education has the potential to enhance students' learning experiences and improve their understanding of mathematical concepts (Dillenbourg, 2008; Hlosta, 2013; Lin & Lin, 2012).

In particular, there is a need to investigate the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts. Online mathematics learning platforms provide students with immediate feedback on their work, allowing them to identify and correct their mistakes. They also provide students with a variety of mathematical problems to solve, ranging from basic arithmetic to more complex algebraic expressions (Jang et al., 2013; Ozguner & Ozguner, 2017; Peker & Calikli, 2017).

However, there is a lack of research on the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts in Zimbabwe. This study aims to fill this gap by investigating the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts at Batanai High School in Glendale Mazowe Mashonaland Central Province, Zimbabwe.

The study will focus on a sample of 50 high school students from Batanai High School. The students will be randomly assigned to two groups: a control group and an experimental group. The control group will continue with their regular mathematics classes, while the experimental group will use the online mathematics learning platform for their mathematics lessons.

The study will use a quasi-experimental design, with pre- and post-tests administered to both groups to measure their understanding of mathematical concepts. The pre-test will be administered at the beginning of the study, while the post-test will be administered at the end of the study. The difference in the scores of the pre-test and post-test will be used to measure the effectiveness of the online mathematics learning platform in enhancing students' understanding of mathematical concepts (Lai & Hwang, 2016; Lin & Lin, 2012).

The study will also gather qualitative data through focus group interviews with students, teachers, and parents to gain a deeper understanding of their experiences and perceptions of using the online mathematics learning platform.

The findings of the study will provide valuable insights into the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts at Batanai High School. The results of the study will also contribute to the existing body of knowledge on the use of ICT in teaching and learning mathematics in Zimbabwe, and provide recommendations for the integration of ICT in mathematics education in the country.

Despite the global advancements in ICT, many schools in Zimbabwe face challenges in effectively integrating these technologies into their curricula, particularly in mathematics. This study seeks to explore these challenges and the potential solutions that ICT provides in teaching quadratic equations. It will also seek to highlight the current level of use of ICT in the teaching of quadratic equations in Mathematics at Ordinary level, in line STEM program

under the Zimbabwe's government leadership of President Cde E.D Mnagagwa's second republic.

Despite the recognized benefits of ICT in education, there is limited research on its application in the teaching of quadratic equations in Zimbabwean secondary schools. This study aims to examine how ICT is utilized at Batanai High School and the impact it has on students' learning of quadratic equations.

Despite the global push for ICT integration in education, many secondary schools in Zimbabwe face challenges in this transition. Batanai High School, while equipped with some technological resources, still employs conventional teaching methods that may not effectively address student engagement and comprehension of quadratic equations. The lack of effective ICT application in teaching these concepts could lead to poor performance and a lack of interest in mathematics among students. This research seeks to identify how ICT can be effectively leveraged to enhance the teaching of quadratic equations, thereby improving student outcomes in mathematical education.

While international research indicates that ICT can significantly improve teaching effectiveness, many Zimbabwean schools, including Batanai High, have yet to fully exploit these technologies in mathematics instruction. Reports highlight deficiencies in both infrastructure and pedagogical training needed to effectively integrate ICT into the classroom (Chigona & Chigona, 2017; Mutekwe & Dzvimbo, 2019). This research seeks to address these gaps by evaluating how ICT is currently used in teaching quadratic equations and exploring its impact on student performance.

### **1.5 Main research question/Research aim**

The main research question for this study is: How ICT enabled instruction for the teaching of quadratic equations?

### **1.6 Sub-questions/Research objectives**

**The research objectives of this study include:**

- To assess the current use of ICT in teaching Quadratic equations at Batanai High School
- To explore the perceptions of teachers and students towards the use of ICT in mathematics education
- To identify the benefits and challenges of using ICT in teaching Quadratic equations

- To propose recommendations for improving the integration of ICT in mathematics education
  - To evaluate the impact of ICT on students' understanding and performance in quadratic equations.
  - To explore the types of ICT tools used in teaching quadratic equations at Batanai High School.
  - To assess the effectiveness of these ICT tools in enhancing students' understanding of quadratic equations.
2. To assess the availability and usage of ICT resources in the teaching process.
  3. To explore the impact of ICT on student understanding and engagement with quadratic equations.
- To provide actionable recommendations for enhancing ICT integration in mathematics instruction.

### 1.7 Hypotheses/assumptions (in quantitative/qualitative research respectively)

The study assumes that the use of ICT in teaching quadratic equations can enhance students' understanding and engagement with the subject. The study also assumes that teachers' attitudes and perceptions towards the use of ICT in teaching quadratic equations can influence their integration of ICT in their teaching practices.

In this qualitative research study, we assume that the use of ICT tools in teaching quadratic equations will lead to improved student engagement, understanding, academic performance in mathematics and by providing interactive and engaging learning experiences for students.

### 1.8 Significance of the study

#### 1. To the Learners:

- **Enhanced Learning Outcomes:** The study can provide insights into effective teaching methods and learning strategies that cater to different learning styles. This can lead to improved academic performance and comprehension among learners.
- **Empowerment and Engagement:** By understanding the findings of the study, learners can become more engaged in their studies. They may gain insights into how to take control of

their learning processes, leading to increased motivation and a sense of ownership over their education.

- Skill Development: The research may identify crucial skills required for academic and personal success. This equips learners with the competencies they need to navigate their educational journeys and prepare for future opportunities.
- Awareness of Educational Resources: The study could raise awareness about available resources, programs, or support systems that learners can access, thereby enhancing their educational experience.
- Contribution to Academic Knowledge: The findings may fill existing gaps in educational research regarding primary and secondary education in Zimbabwe. This provides a foundation for future studies and encourages on-going scholarly discussion.
- Methodological Insights: Researchers can learn from the methodologies employed in the study, which can enhance the quality of their future research designs. This could include insights into data collection techniques, analysis methods, and ethical considerations.
- Network and Collaboration Opportunities: The study may lead to increased collaboration among researchers in Zimbabwe and internationally. This can foster a supportive academic community and promote collective efforts to address educational challenges.
- Benchmarking and Best Practices: Researchers can identify best practices implemented within the educational system, contributing to models that may be replicated or adapted in similar contexts.

### 3. To the Ministry of Primary and Secondary Education:

- Informed Policy Making: The study can provide evidence-based recommendations that the Ministry can use to shape educational policies and practices. This can lead to more effective policies that are grounded in current research and the realities of the educational landscape.
- Resource Allocation and Program Development: Insights from the study can guide the Ministry in allocating resources efficiently and developing programs that align with the needs of learners and educators.
- Monitoring and Evaluation: The findings can assist the Ministry in developing monitoring and evaluation frameworks to assess educational initiatives, ensuring they meet defined goals and improve educational outcomes.

-National Educational Standards: The study can contribute to discussions around setting and maintaining educational standards in Zimbabwe, ensuring that all learners have access to quality education.

The integration of Information and Communication Technology (ICT) in education has become increasingly important in recent years. As the world becomes more digital, the use of ICT in teaching and a critical component of education. In the field of mathematics, the use of ICT has the potential to enhance students' learning experiences and improve their understanding of mathematical concepts (Dillenbourg, 2008; Hlosta, 2013; Lin & Lin, 2012).

Despite the importance of ICT in education, there is a lack of research on the use of ICT in teaching and learning mathematics in Zimbabwe. This study aims to fill this gap by investigating the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts at Batanai High School in Glendale Mazowe Mashonaland Central Province, Zimbabwe.

The online mathematics learning platform being studied is a web-based application that provides interactive mathematics lessons and exercises. The platform is designed to provide students with immediate feedback on their allowing them to identify and correct their mistakes. The platform also provides students with a variety of mathematical problems to solve, ranging from basic arithmetic to more complex algebraic expressions (Jang et al., 2013; Ozguner & Ozguner, 2017; Peker & Calikli, 2017).

The study focuses on a sample of 50 high school students from Batanai High School. The students will be randomly assigned to two groups: a control group and an experimental group. The control group will continue with their regular mathematics classes, while the experimental group will use ICT mathematics learning platforms for their mathematics lessons.

The study will use a quasi-experimental design, with pre- and post-tests administered to both groups to measure their understanding of mathematical concepts. The pre-test will be administered at the beginning of the study, while the post-test will be administered at the end of the study. The difference in the scores of the pre-test and post-test will be used to measure the effectiveness of the online mathematics learning platform in enhancing students' understanding of mathematical concepts (Lai & Hwang, 2016; Lin & Lin, 2012).

The study will also gather qualitative data through focus group interviews with students, teachers, and parents to gain a deeper understanding of their experiences and perceptions of using the online mathematics learning platform.

The findings of the study will provide valuable insights into the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts at Batanai High School. The results of the study will also contribute to the existing body of knowledge on the use of ICT in teaching and learning mathematics in Zimbabwe, and provide recommendations for the integration of ICT in mathematics education in the country.

The integration of Information and Communication Technology (ICT) in education has become increasingly important in recent years. As the world becomes more digital, the use of ICT in teaching and learning has become a critical component of education. In the field of mathematics, the use of ICT has the potential to enhance students' learning experiences and improve their understanding of mathematical concepts (Dillenbourg, 2008; Hlosta, 2013; Lin & Lin, 2012).

Despite the importance of ICT in education, there is a lack of research on the use of ICT in teaching and learning mathematics in Zimbabwe. This study aims to fill this gap by investigating the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts at School in Batanai High in Mazowe Mashonaland Central Province, Zimbabwe.

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The study will focus on a sample of 50 high school school students from School. The students will Batanai High be randomly assigned to two groups: a control group and an experimental group. The control group will continue with their regular mathematics classes, while the experimental group will use the online mathematics learning platform for their mathematics lessons.

The study will also gather qualitative data through focus group interviews with students, teachers, and parents to gain a deeper understanding of their experiences and perceptions of using the online mathematics learning platform.

The findings of the study will provide valuable insights into the effectiveness of using an online mathematics learning platform in enhancing students' understanding of mathematical concepts at Batanai High School. The results of the study will also contribute to the existing body of knowledge on the use of ICT in teaching and learning mathematics in Zimbabwe, and provide recommendations for the integration of ICT in mathematics education in the country.

This study is significant because it will provide insights into the effectiveness of ICT in teaching quadratic equations, which can inform educational practices and policies. The findings will benefit teachers, students, and educational stakeholders by highlighting best practices and addressing challenges in ICT integration (Mafa & Mpofu, 2013; UNESCO, 2020).

This study is significant as it provides insights into the effective use of ICT in teaching mathematics in rural schools in Zimbabwe. The findings can inform policy makers, educators, and stakeholders on best practices for integrating ICT in education.

This study is significant as it will provide insights into the current state of ICT integration in mathematics education in Zimbabwe. It will also contribute to the existing body of knowledge and offer recommendations for improving ICT usage in teaching quadratic equations.

The findings of this research are significant for educators, policymakers, and educational institutions in Zimbabwe. By focusing on the practical application of ICT in mathematics teaching, the study aims to contribute to improved educational practices and provide insights that could influence curriculum development and teacher training in the region (Mutekwe, 2014).

Integrating Information and Communication Technology (ICT) in education for students in Zimbabwe can yield several potential long-term benefits:

- **Enhanced Learning Experiences:** ICT tools can create interactive and engaging learning environments, catering to various learning styles. This can lead to improved understanding and retention of knowledge.

**-Access to Information:** With ICT, students can access a wealth of online resources, research materials, and educational platforms. This broadens their learning opportunities beyond traditional textbooks.

**-Improved Digital Literacy:** As students engage with technology, they develop essential digital skills that are increasingly important in today's job market. This prepares them for future careers where technology plays a critical role.

**-Collaboration and Communication:** ICT facilitates collaboration among students and teachers through tools like online forums, group projects, and video conferencing. This fosters teamwork and enhances communication skills.

**- Personalized Learning:** Technology allows for personalized learning experiences, where students can learn at their own pace. Adaptive learning software can cater to individual strengths and weaknesses, promoting mastery of concepts.

**-Preparation for the Workforce:** Familiarity with ICT tools prepares students for the modern workforce, where digital competency is often a prerequisite. This can improve employability and adaptability in various industries.

**-Support for Teachers:** ICT can enhance teachers' professional development, providing them with new teaching strategies, resources, and tools for assessment. This can lead to improved teaching practices and better educational outcomes.

**-Promotion of Lifelong Learning:** By integrating ICT, students can cultivate a habit of independent and lifelong learning. They are likely to continue seeking knowledge and skills beyond formal education settings.

**-Bridging Educational Gaps:** ICT can help bridge educational disparities by providing access to quality educational resources, even in remote areas. This can contribute to a more equitable education system.

10. **Encouragement of Critical Thinking and Problem-Solving:** Engaging with technology can encourage students to think critically and solve problems creatively, skills that are vital in both academic and real-world contexts.

By embracing ICT in education, Zimbabwe can significantly enhance the quality of its educational system and better prepare its students for future challenges and opportunities.

### 1.9 Delimitations

The study focuses on the use of ICT in teaching quadratic equations and does not consider other aspects of mathematics education. Additionally, the study is based on a sample of secondary mathematics students and teachers and may not be representative of the entire population of secondary mathematics students and teachers in Zimbabwe.

Delimitations define the scope and boundaries of the study, specifying what is included and excluded. The following delimitations are set for this research:

**Geographical Scope:** The study is confined to Batanai High School in Glenale, Mazowe, Mashonaland Central Province, Zimbabwe. Findings may not be generalizable to other regions or countries.

**Subject Focus:** The research focuses specifically on the use of ICT in teaching quadratic equations within the secondary mathematics curriculum. Other subjects or mathematical topics are not considered.

**ICT Tools:** The study examines the use of specific ICT tools, such as interactive software, online resources, and digital platforms. Other forms of technology, such as hardware devices or non-digital teaching aids, are not included.

**Participant Selection:** Only mathematics teachers and secondary students at Batanai High School are included in the study. Other staff members, parents, or external stakeholders are not part of the research.

### 1.10 Limitations

Some limitations of this study may include the availability of ICT resources, teacher training in using technology, and student access to devices. These factors may impact the implementation and effectiveness of ICT in teaching Quadratic equations.

While this study aims to provide valuable insights into ICT integration in teaching quadratic equations, certain limitations must be acknowledged:

Generalizability: The findings may not be generalizable to all Zimbabwean secondary schools, as the sample may not fully represent the entire population.

Self-Report Bias: The reliance on self-reported data may introduce bias, as participants may provide responses they perceive as desirable rather than their true experiences.

Temporal Context: The study is conducted at a specific time, and the findings may not reflect future developments in ICT integration in education. Limitations are potential weaknesses or constraints in the study that may affect the results or generalizability of the findings. The following limitations are identified for this research:

**Sample Size**: The study is limited to a sample of 10 teachers and 100 students from Batanai High School. This relatively small sample size may not fully represent the broader population of secondary schools in Zimbabwe.

**Time Constraints**: The data collection period is limited to four weeks, which may not be sufficient to capture long-term effects of ICT integration in teaching quadratic equations.

**Resource Availability**: The availability and quality of ICT resources at Batanai High School may vary, potentially influencing the effectiveness of ICT integration and the study's findings.

**Self-Reported Data**: Data collected through surveys and interviews rely on self-reported information, which may be subject to biases such as social desirability or recall bias.

**Technological Proficiency**: The varying levels of technological proficiency among teachers and students may impact their ability to effectively use ICT tools, influencing the study's outcomes.

### **1.11 Definition of terms**

**ICT (Information and Communication Technology)**: Refers to technologies that provide access to information through telecommunications, including the internet, wireless networks, cell phones, and other communication mediums (UNESCO, 2020).

**Quadratic Equations**: A type of polynomial equation of the second degree, typically in the form  $(ax^2 + bx + c = 0)$ .

**Secondary Mathematics**: The branch of mathematics taught at the secondary school level, covering topics such as algebra, geometry, and calculus.

**ICT (Information and Communication Technology)**: Refers to technologies that provide access to information through telecommunications, including the internet, wireless networks, cell phones, and other communication mediums.

**Quadratic Equations**: A type of polynomial equation of the second degree, typically in the form  $(ax^2 + bx + c = 0)$ .

Secondary Mathematics: The branch of mathematics taught at the secondary school level, covering topics such as algebra, geometry, and calculus.

- ICT: Information and Communication Technology

- Quadratic equations: Algebraic equations of the form  $ax^2 + bx + c = 0$

- Mathematics education: The teaching and learning of mathematical concepts and skills

ICT: Information and Communication Technology

Quadratic equations: A type of polynomial equation in which the highest exponent of the variable is 2.

Secondary mathematics: The study of mathematics in the secondary education system, which typically includes Forms 1-6.

Teaching: The process of imparting knowledge and skills to students.

Integration: The process of incorporating different elements or components into a unified whole.

Attitudes: A person's feelings or disposition towards something.

Perceptions: The way in which a person interprets or understands something.

### **1.12 Organisation of the study**

This study is organized into several chapters, including an introduction, literature review, methodology, results, discussion, and conclusion. Each chapter will address specific aspects of the research topic to provide a comprehensive analysis of the use of ICT in teaching Quadratic equations.

This study is organized into five chapters, including an introduction, literature review, research methodology, data analysis, and conclusions. Each chapter will provide a detailed exploration of the research topic and contribute to the overall understanding of the use of ICT in teaching quadratic equations.

### **1.13 Chapter summary**

In summary, this study aims to investigate the use of ICT in teaching quadratic equations to secondary mathematics students at Batanai High School in Mazowe, Zimbabwe. The study aims to examine the current practices and approaches used by teachers in integrating ICT in teaching quadratic equations, identify the benefits and challenges of using ICT in teaching

quadratic equations, and explore the attitudes and perceptions of secondary mathematics students towards the use of ICT in teaching quadratic equations. The study is significant in contributing to the broader body of knowledge on the use of ICT in mathematics education and providing valuable insights into the attitudes and perceptions of secondary mathematics students towards the use of ICT in teaching quadratic equations.

In this chapter, the study has been introduced, including the background of the study, the purpose of the study, the research question, the research objectives, the hypotheses, the significance of the study, the delimitations, the limitations, the definition of terms, and the organization of the study. The study aims to examine the use of ICT in teaching quadratic equations to secondary mathematics students at Batanai High School in Glendale Mazowe Mashonaland Central Province, Zimbabwe. The study will be conducted over a period of three months and will involve interviews and surveys with teachers and students at the school. The data collected will be analysed using qualitative data analysis software to identify themes and patterns in the data. The findings of the study will be discussed in relation to the existing literature on the use of ICT in mathematics education and the teaching of quadratic equations. The study aims to provide recommendations for the integration of ICT in teaching quadratic equations in Zimbabwe.

## **CHAPTER 2: REVIEW OF RELATED LITERATURE REVIEW**

### **2.0 Introduction**

#### **2.1 Literature review**

In this chapter, the use of Information and Communication Technology (ICT) in teaching quadratic equations to secondary maths students at Batanai High School in Mvurwi will be examined. The chapter will review relevant literature on the integration of ICT in mathematics education, specifically focusing on the teaching of quadratic equations. The aim is to explore how ICT can enhance the learning experience and understanding of quadratic equations among secondary maths students.

This chapter reviews existing literature on the integration of Information and Communication Technology (ICT) in the teaching of mathematics, with a specific focus on quadratic equations. It examines theoretical frameworks, empirical studies, and practical applications that illustrate the impact of ICT on teaching and learning processes.

The integration of Information and Communication Technology (ICT) in education has been a topic of interest for researchers and educators for several years. The use of ICT in teaching mathematics has the potential to enhance students' understanding and engagement with the subject. However, there is a need for more research on the current practices and approaches used by teachers in integrating ICT in teaching mathematics, particularly in the context of quadratic equations.

The integration of Information and Communication Technology (ICT) in the teaching and learning of mathematics has garnered significant attention within the educational research community, particularly in the context of secondary schools. The literature reveals a complex interplay of opportunities and challenges that educators face when incorporating technology into their pedagogical practices.

(Amuko et al., 2015) underscore the importance of teachers' beliefs about mathematics learning with technology, noting that initial resistance often stems from a perception that technology complicates their teaching efforts. Their study highlights that inadequate resources, such as infrastructure and training, significantly hinder the adoption of ICT in Kenyan secondary schools. Teachers' fears of equipment failure further exacerbate this issue, suggesting that a supportive environment is essential for fostering technology use in classrooms.

Building on this foundation, (Umugiraneza et al., 2018) explore the specific context of KwaZulu-Natal, where they examine teachers' knowledge, beliefs, and confidence regarding technology integration in mathematics instruction. Their quantitative study reveals that while teachers recognize the potential benefits of technology, their actual implementation is often limited by a lack of access to digital tools and insufficient professional development. This indicates a pressing need for targeted training programs to enhance teachers' confidence and competence in using ICT effectively.

In a broader context, (Johnson Dei, 2018) emphasizes the transformative role of ICT in educational settings, arguing that it necessitates a shift away from traditional teaching methodologies. Despite the acknowledged value of ICT, the persistent challenges of inadequate computer skills among educators hinder its effective integration. This finding resonates with the earlier studies, reinforcing the notion that teacher preparedness is crucial for successful technology adoption in mathematics education. (W. N. C. K. Palagolla & P. R. Wickramarachchi, 2019) further investigate the barriers to effective ICT integration in Sri Lanka, identifying both organizational and individual factors that impact technology use in secondary schools. Their research highlights the critical role of leadership support and ICT infrastructure, alongside teachers' attitudes and competencies. The authors suggest that without addressing these multifaceted barriers, the potential of ICT to enhance educational outcomes will remain largely untapped.

Continuing in the same vein, the authors' subsequent work ((W. N. C. K. Palagolla & P. R. Wickramarachchi, 2019)) indicates that while ICT utilization is higher among more experienced teachers, existing training programs fall short in equipping educators with the necessary skills for integrating technology into their teaching practices. Their findings suggest that enhancing ICT infrastructure and providing comprehensive training can significantly improve both teacher performance and student outcomes.

The literature on ICT in education suggests that technology can facilitate active learning, foster collaboration, and enhance problem-solving skills among students (Maharaj, 2019). Specifically, tools such as graphing software and online learning platforms can provide interactive environments for students to explore the properties of quadratic equations (Ogunniyi, 2020).

Studies conducted in various contexts indicate that integrating ICT into mathematics education can lead to improved student engagement and academic performance (Chaka,

2021). Moreover, the Zimbabwean context presents unique challenges and opportunities that necessitate a tailored approach to ICT integration in mathematics teaching.

The literature on the use of ICT in education highlights various benefits, including increased student motivation, improved learning outcomes, and enhanced teaching effectiveness. Local studies, such as those conducted by Machingura (2018), show that ICT tools like computers and tablets can significantly aid in teaching complex mathematical concepts.

Regionally, a study by Mwale and Muliya (2020) in Zambia emphasizes the role of interactive software in teaching mathematics, demonstrating improved student performance in quadratic equations. Internationally, research by Hattie (2009) suggests that the use of technology can lead to substantial gains in student achievement when effectively integrated into teaching practices.

Overall, the literature presents a nuanced understanding of the dynamics surrounding ICT integration in mathematics education at the secondary school level. The critical evaluation of these studies reveals that while there is a consensus on the importance of technology in enhancing educational practices, the path to effective integration is fraught with challenges that require concerted efforts from educational stakeholders.

This chapter reviews existing literature on the integration of Information and Communication Technology (ICT) in the teaching of mathematics, with a specific focus on quadratic equations. It examines theoretical frameworks, empirical studies, and practical applications that illustrate the impact of ICT on teaching and learning processes.

The purpose of this chapter is to review the existing literature on the use of ICT in teaching mathematics, with a focus on quadratic equations. The chapter begins by introducing the topic and highlighting the importance of the study.

The first section of the chapter focuses on the benefits of using ICT in teaching quadratic equations. Several studies have shown that the use of ICT in teaching mathematics can have a positive impact on students' learning outcomes. For example, computer-based tools can help students to visualize mathematical concepts and improve their problem-solving skills. Interactive whiteboards can enhance students' engagement and motivation by providing interactive and multimedia learning experiences.

The next section of the chapter focuses on the challenges of using ICT in teaching quadratic equations. Despite the potential benefits of using ICT, there are also several challenges

associated with its integration. Technical issues such as computer crashes and software errors can disrupt the learning process. Additionally, some teachers may not have the necessary skills or knowledge to effectively integrate ICT into their teaching practices.

The final section of the chapter focuses on the attitudes and perceptions of secondary mathematics students towards the use of ICT in teaching quadratic equations. The attitudes and perceptions of students can have a significant impact on the effectiveness of ICT in teaching mathematics. Students who have positive attitudes towards the use of ICT are more likely to engage with the material and achieve better learning outcomes. On the other hand, students who have negative attitudes towards the use of ICT may be less engaged and have lower learning outcomes.

The chapter concludes by identifying research gaps in the literature, particularly in the context of Zimbabwe. There is limited research on the current practices and approaches used by teachers in integrating ICT in teaching quadratic equations in Zimbabwe. Additionally, there is limited research on the attitudes and perceptions of secondary mathematics students towards the use of ICT in teaching quadratic equations in Zimbabwe.

Overall, this chapter provides an overview of the existing literature on the use of ICT in teaching mathematics, with a focus on quadratic equations. The chapter highlights the potential benefits and challenges of using ICT in teaching quadratic equations, as well as the impact of students' attitudes and perceptions on the effectiveness of ICT in teaching mathematics. The chapter also identifies research gaps in the literature, particularly in the context of Zimbabwe, which will guide the study.

## **2.2 Integration of ICT in Mathematics Education**

According to a study by Haciomeroglu (2016), the integration of ICT in mathematics education has been shown to improve students' problem-solving skills, critical thinking, and overall understanding of mathematical concepts. ICT tools such as graphing calculators, interactive whiteboards, and educational software can provide students with visual representations of mathematical concepts, making abstract ideas more concrete and easier to grasp.

### **2.2.1 Benefits of using ICT in teaching quadratic equations**

The benefits of using ICT (Information and Communication Technology) to teach quadratic equations include:

Improved understanding and visualization

1. **Enhanced visualization:** ICT tools, such as graphing software and interactive apps, enable students to visualize quadratic equations, making it easier to understand complex concepts (Kaput, 1992).

2. **Interactive exploration:** ICT allows students to explore quadratic equations interactively, promoting a deeper understanding of the relationships between variables (Hoyles & Noss, 2003).

3. **Increased engagement and motivation**

1. Game-based learning: ICT-based games and simulations can increase student engagement and motivation, making learning quadratic equations more enjoyable (Wouters et al., 2013).

2. Real-world applications: ICT can help students see the relevance of quadratic equations to real-world problems, increasing their interest and motivation (Niss, 1999).

Personalized learning and feedback

1. Adaptive assessments: ICT-based assessments can adapt to individual students' needs, providing personalized feedback and guidance (Bennett, 2015).

2. Automated grading: ICT can automate grading, freeing instructors to focus on providing feedback and support (Baker, 2016).

Collaboration and communication

1. Online discussions: ICT enables students to participate in online discussions, sharing ideas and collaborating on problem-solving (Harasim, 2017).

2. Multimedia presentations: ICT allows students to create multimedia presentations, communicating their understanding of quadratic equations in a more engaging and interactive way (Mishra & Koehler, 2006).

## 2.3 Teaching Quadratic Equations with ICT.

Research by Kirschner et al. (2018) suggests that using ICT in teaching quadratic equations can help students visualize the relationship between the equation, the graph, and the

solutions. Interactive graphing software, for example, allows students to manipulate the parameters of a quadratic equation and observe how it affects the shape and position of the graph. This hands-on approach can deepen students' understanding of quadratic equations and help them make connections between algebraic and graphical representations.

Studies have shown that using ICT in teaching quadratic equations can increase student engagement and motivation (Bakker et al., 2016). Interactive activities and simulations can make learning more interactive and enjoyable for students, leading to improved retention and understanding of mathematical concepts. Additionally, ICT tools can provide immediate feedback to students, allowing them to track their progress and identify areas for improvement.

Numerous studies have highlighted the benefits of ICT in mathematics education:

**Increased Engagement:** Research indicates that the use of ICT tools, such as graphing calculators and interactive software, leads to higher levels of student engagement and motivation (Hegedus & Kaput, 2009).

**Visual Learning:** ICT can provide visual representations of mathematical concepts, making abstract ideas more concrete. Tools like dynamic geometry software allow students to visualize and manipulate quadratic functions, enhancing their understanding (Laborde, 2009).

**Immediate Feedback:** Online platforms and educational software can offer instant feedback on assessments, helping students identify areas for improvement and fostering a growth mind-set (Baker, 2008).

Several studies have shown that the use of ICT in teaching mathematics can have a positive impact on students' learning outcomes. For example, a study by Dillenbourg et al. (2005) found that students who used computer-based tools to solve mathematical problems showed a significant improvement in their problem-solving skills compared to those who did not use such tools. Similarly, a study by Hwang et al. (2012) found that the use of interactive whiteboards in teaching mathematics enhanced students' engagement and motivation.

## **2.4 Challenges of using ICT in teaching quadratic equations**

Despite the potential benefits of using ICT in teaching mathematics, there are also several challenges associated with its integration. For example, a study by Lin et al. (2013) found that teachers often face technical issues when using ICT tools in the classroom, such as computer

crashes and software errors. Additionally, some teachers may not have the necessary skills or knowledge to effectively integrate ICT into their teaching practices.

While the benefits of ICT in education are significant, there are challenges specific to the Zimbabwean context:

Resource Limitations: Many schools lack the necessary infrastructure, such as computers, internet access, and reliable power supply, which hinders effective ICT integration (Chikoko et al., 2015).

Training and Professional Development: Teachers often require training to effectively incorporate ICT into their teaching practices. A lack of professional development opportunities can limit their ability to utilize technology effectively (Mlambo & Mavhunga, 2018).

Resistance to Change: Traditional teaching methods are deeply rooted in the educational culture, and there may be resistance from educators and administrators to adopt new technologies (Munyoro, 2020).

## **2.5 Attitudes and perceptions of secondary mathematics students towards the use of ICT in teaching quadratic equations**

The attitudes and perceptions of students towards the use of ICT in teaching mathematics can also have an impact on its effectiveness. A study by Zhang et al. (2013) found that students who had positive attitudes towards the use of ICT in teaching mathematics were more likely to engage with the material and achieve better learning outcomes. On the other hand, students who had negative attitudes towards the use of ICT were less likely to engage with the material and had lower learning outcomes.

## **2.6 Local Studies on ICT in Zimbabwean Education**

In Zimbabwe, studies have highlighted both the potential and challenges of ICT in education. According to Chikoko et al. (2015), there is a growing recognition of the importance of ICT in enhancing teaching practices, yet infrastructure and resource limitations persist. The authors emphasize the need for training teachers to effectively integrate ICT into their teaching methodologies.

### 2.6.1 Regional Studies

Regional studies, such as that conducted by Muliya & Mwale (2020) in Zambia, underscore the transformative impact of ICT in mathematics education. The study revealed that the use of interactive software not only improved students' understanding of quadratic equations but also increased their motivation to learn. This aligns with findings by Ochieng (2017), who noted that ICT tools foster collaborative learning environments and promote problem-solving skills among students.

### 2.6.2 International Perspectives

Internationally, the role of ICT in mathematics education has been extensively documented. A meta-analysis by Hattie (2009) concluded that technology can lead to significant improvements in student performance when integrated thoughtfully into teaching practices. Furthermore, a study by Li & Ma (2010) suggests that the effectiveness of ICT in education is influenced by factors such as teacher proficiency with technology and the availability of resources.

## 2.7 Theoretical Framework

The integration of ICT in education can be understood through several theoretical frameworks:

- **Constructivist Learning Theory:** This theory states that learners construct knowledge through experiences and interactions. ICT enables collaborative learning environments where students can engage with peers and explore mathematical concepts actively (Piaget, 1973). Constructivism posits that learners build their understanding and knowledge through experiences and reflecting on those experiences. ICT can be used to create interactive environments where students explore quadratic equations through simulations and visualizations.

- **Technological Pedagogical Content Knowledge (TPACK):**

This framework emphasizes the intersection of technology, pedagogy, and content knowledge. Effective integration of ICT requires teachers to possess the necessary skills and knowledge to utilize technology in teaching specific content areas, such as quadratic equations (Mishra & Koehler, 2006). The TPACK framework emphasizes the integration of technology into teaching and how it enhances pedagogical strategies and content knowledge.

Teachers need to understand how to effectively combine technology with mathematics content, such as quadratic equations.

### **-Cognitive Load Theory**

Cognitive Load Theory (CLT) suggests that learning happens best when the cognitive load is managed appropriately. ICT tools, such as dynamic geometry software, provide visual representations that can reduce extraneous cognitive load, allowing students to focus on conceptual understanding of quadratic equations.

### **- Social Constructivism**

This framework highlights the importance of social interactions and the role of collaborative learning in education. ICT can facilitate collaborative activities that allow students to work together on problems involving quadratic equations, supporting peer learning and communication.

### **- Experiential Learning Theory**

Experiential Learning Theory (ELT) emphasizes learning through experience. ICT tools can provide opportunities for hands-on experimentation with quadratic equations, allowing students to engage actively with mathematical concepts. Integrating ICT into the teaching of quadratic equations aligns with various educational theories that support active, collaborative, and meaningful learning experiences. Each framework underscores the benefits of using technology to enhance understanding and engagement in mathematics.

## **2.5.4 Empirical Studies**

Several empirical studies have explored the impact of ICT on teaching quadratic equations and mathematics in general:

- Munyoro (2020) conducted a study in Harare and found that students who used ICT tools to learn quadratic equations demonstrated a deeper understanding of the concepts compared to those who did not.

- Chaka (2021) highlighted that teachers who integrated ICT into their lessons reported increased student participation and enthusiasm, leading to improved academic performance in mathematics.
- Ogunniyi (2020) emphasized that using online simulations and interactive software can enhance students' problem-solving skills and conceptual understanding of quadratic equations.

Several empirical studies have explored the impact of ICT on teaching quadratic equations and mathematics in general:

#### Empirical Studies on the Impact of ICT in Teaching Mathematics

##### 1. **Zimbabwe-Based Study**

- Chikoko, V., & Mupfurutsa, C. (2020). The effect of ICT integration on the teaching of mathematics in Zimbabwean secondary schools: Implications for pedagogy. *Zimbabwe Journal of Educational Research*, 32(3), 45-59.

- This study investigates how ICT tools enhance mathematics teaching effectiveness, with a focus on secondary school teachers' experiences and student outcomes.

- Mavhunga, E., & Rollnick, M. (2013). The study investigated the use of ICT in teaching quadratic equations in Zimbabwean secondary schools. The findings indicated that ICT tools, such as graphing software, significantly improved students' understanding and engagement with quadratic equations.

##### 2. **SADC Region Study (Southern Africa Development Community)**

- Ndlovu, D., & Mphahlele, M. (2021). Leveraging technology for improving mathematics education in the SADC region: Lessons learned from the implementation of ICT initiatives. *Journal of Southern African Education Research*, 28(2), 95-110.

- This research explores various ICT initiatives across SADC countries and how they impact student understanding in mathematics, including problem-solving in quadratic equations.

- Mauro, L., & Ramnarain, U. (2020). This study explored the integration of ICT in teaching mathematics, including quadratic equations, in South African schools. The results showed that ICT tools enhanced students' conceptual understanding and problem-solving skills.

### **3. African Region Study**

- Obi, A. J., & Fadeyi, A. (2019). Access and utilization of ICT resources in teaching mathematics in African secondary schools: A survey of selected countries. *African Journal of Education and Development Studies*, 14(1), 25-38.

- This study surveys ICT resource access and usage among mathematics teachers in several African countries, exploring the correlation between ICT use and student performance in mathematics.

- Adu, E. O., & Olatundun, S. A. (2013). This research examined the impact of ICT on teaching quadratic equations in Nigerian secondary schools. The study found that students taught with ICT tools performed better in understanding and solving quadratic equations compared to those taught with traditional methods.

#### **Nigeria:**

- Ogunleye, A. O., & Adeyemo, S. A. (2011). This study investigated the effects of computer-assisted instruction on students' performance in quadratic equations. The findings revealed that students who received computer-assisted instruction performed significantly better than those who were taught using traditional method.

#### **Tanzania:**

- Kafyulilo, A. C. (2014) . This research focused on the use of ICT in teaching mathematics, including quadratic equations, in Tanzanian secondary schools. The study found that ICT tools, such as educational software and interactive whiteboards, significantly improved students' understanding and engagement.

#### **Uganda:**

- Nabukenya, J., & Musoke, M. (2014). This study examined the impact of ICT on teaching and learning quadratic equations in Ugandan secondary schools. The results indicated that the use of ICT tools, such as graphing calculators and educational software, enhanced students' problem-solving skills and conceptual understanding.

#### **Ethiopia:**

- Tadesse, T., & Gillies, R. M. (2015). This research explored the integration of ICT in teaching mathematics, including quadratic equations, in Ethiopian secondary schools. The

study found that ICT tools improved students' engagement and understanding of mathematical concepts.

- Reference: Tadesse, T., & Gillies, R. M. (2015). ICT integration in teaching mathematics in Ethiopian secondary schools. *Journal of Education and Practice*, 6(4), 1-10. <https://doi.org/10.7176/JEP/6-4-1>

These studies further illustrate the positive impact of ICT on teaching quadratic equations, showing improvements in students' understanding, engagement, and performance across different African countries.

#### **4. International Study**

- Teo, T., & Wong, S. (2018) performs a meta-analysis of multiple studies examining the relationship between ICT use in mathematics education and student achievement globally, including insights relevant to quadratic equations.

#### **5. Case Study in Nigeria (as a representative study from the African region)**

- Ajayi, A. O., & Obamuyi, T. (2022). Impact of smartphone technology on learning quadratic equations among secondary school students in Nigeria. *Journal of Educational Technology Systems*, 50(1), 76-89. This case study investigates how the availability of smartphones as educational tools can affect students' understanding of quadratic equations within the Nigerian context.

#### **6. Global Perspective**

- Wang, Y., & Zhuang, R. (2023). Analyzing the effectiveness of online learning platforms in teaching mathematics: A global overview. *Computers & Education*, 179, 104420. This broader study analyses the effectiveness of various online learning platforms, highlighting their role in improving the teaching and learning of mathematics, including quadratic equations. Kim How, R. P. T., Zulnaidi, H., & Abdul Rahim, S. S. (2022). This study focused on the importance of digital literacy in teaching quadratic equations in Malaysia. It highlighted the benefits of using ICT tools, such as increased motivation and improved problem-solving skills among students.

These studies collectively demonstrate the positive impact of ICT on teaching quadratic equations, enhancing students' understanding, engagement, and performance in mathematics.

## **Challenges of ICT Integration in Zimbabwe**

While the benefits of ICT in education are significant, there are challenges specific to the Zimbabwean context:

- **Resource Limitations**: Many schools lack the necessary infrastructure, such as computers, internet access, and reliable power supply, which hinders effective ICT integration (Chikoko et al., 2015).

- **Training and Professional Development**: Teachers often require training to effectively incorporate ICT into their teaching practices. A lack of professional development opportunities can limit their ability to utilize technology effectively (Mlambo & Mavhunga, 2018).

- **Resistance to Change**: Traditional teaching methods are deeply rooted in the educational culture, and there may be resistance from educators and administrators to adopt new technologies (Munyoro, 2020).

## **ICT in Education: Global Perspectives**

Globally, ICT has been recognized as a powerful tool for improving educational outcomes. Studies have shown that ICT can enhance student motivation, facilitate personalized learning, and improve academic performance (UNESCO, 2020; OECD, 2015). For example, the use of interactive software and online resources has been found to significantly improve students' understanding of complex mathematical concepts (Higgins et al., 2012).

## **ICT in Education: African Context**

In Africa, the adoption of ICT in education has been slower due to various challenges, including limited infrastructure, lack of training, and financial constraints (Chigona et al., 2014). However, there are notable efforts and success stories. For instance, the use of mobile learning platforms has shown promise in improving access to educational resources in remote areas (Mtebe & Raisamo, 2014).

## **ICT in Education: Zimbabwean Context**

In Zimbabwe, the integration of ICT in education is still in its nascent stages. Studies have highlighted both the potential benefits and the challenges faced by educators. Mafa and

Mpofu (2013) found that while ICT can enhance the teaching of mathematics, issues such as inadequate resources and lack of teacher training hinder its effective use. Despite these challenges, there are ongoing initiatives aimed at improving ICT infrastructure and training in schools (Mafa & Mpofu, 2013).

### **ICT in Teaching Quadratic Equations**

Quadratic equations are a critical component of the secondary mathematics curriculum. Research indicates that ICT tools, such as graphing software and interactive simulations, can significantly aid in teaching and understanding quadratic equations (Higgins et al., 2012). These tools allow students to visualize and manipulate equations, leading to a deeper comprehension of the concepts involved.

#### **2.7 ICT tools that can be highly effective for teaching quadratic equations**

##### **1. Gepgebra:**

- Description: A dynamic mathematics software that integrates geometry, algebra, and calculus.
- Uses: Visualizing quadratic functions, exploring transformations, and solving equations interactively.
- Benefits: Enhances students' understanding through visual representation and interactive manipulation.

##### **2. Desmos:**

- Description: An advanced graphing calculator implemented as a web application.
- Uses: Plotting quadratic equations, analysing graphs, and exploring the effects of changing coefficients.
- Benefits: User-friendly interface that helps students visualize and understand the behaviour of quadratic functions<sup>6</sup>.

##### **3. Microsoft Mathematics:**

- Description: A free educational program that helps solve mathematical problems and provides step-by-step solutions.

- Uses: Solving quadratic equations, graphing functions, and performing algebraic manipulations.

- Benefits: Provides detailed solutions and explanations, aiding in the learning process<sup>4</sup>.

#### 4. SketchUp:

- Description: A 3D modelling software that can be used to create geometric shapes and visualize mathematical concepts.

- Uses: Visualizing quadratic surfaces and exploring the geometric interpretations of quadratic equations.

- Benefits: Helps students understand the spatial aspects of quadratic equations<sup>4</sup>.

#### 5. MathsPad:

- Description: An online platform offering interactive math tools and resources.

- Uses: Interactive activities for solving and graphing quadratic equations.

- Benefits: Engages students with hands-on activities and visual aids<sup>4</sup>.

These tools can significantly enhance the teaching and learning experience by making abstract concepts more tangible and interactive.

Using ICT (Information and Communication Technology) tools can make learning and teaching quadratic equations more interactive and engaging. Here are some steps and resources to help you factorize quadratic expressions and complete the square using ICT:

### **Factorizing Quadratic Expressions**

1. Identify the quadratic expression: A quadratic expression is generally in the form  $(ax^2 + bx + c)$ .

2. Use online tools: Websites like [Symbolab](<https://www.symbolab.com>) and [WolframAlpha](<https://www.wolframalpha.com>) can factorize quadratic expressions for you. Simply input the expression, and these tools will show the factorization steps.

3. Educational videos: Watch tutorials like [NancyPi's video on factoring quadratics]([https://www.youtube.com/watch?v=YtN9\\_tCaRQc](https://www.youtube.com/watch?v=YtN9_tCaRQc)) which explains different methods to factorize quadratic expressions.

## Completing the Square

1. Rewrite the quadratic expression: Start with the expression  $(ax^2 + bx + c)$ .
2. Use ICT tools: Tools like [GeoGebra](https://www.geogebra.org) provide interactive ways to complete the square. You can manipulate the equation and see the steps visually.
3. Step-by-step guides: Videos such as [The Organic Chemistry Tutor's tutorial](https://www.youtube.com/watch?v=C206SNAXDGE) explain how to complete the square methodically.

### Example

Let's factorize and complete the square for  $(x^2 + 6x + 9)$ :

#### 1. Factorizing:

- Recognize that  $(x^2 + 6x + 9)$  can be written as  $(x + 3)^2$ .

#### 2. Completing the Square:

- Start with  $(x^2 + 6x + 9)$ .
- Rewrite it as  $(x^2 + 6x + 9 = (x + 3)^2)$ .

### ICT in Teaching

Using ICT in teaching quadratic equations can include:

- Interactive whiteboards: To visually demonstrate the steps.
- Mathematics software: Like GeoGebra for dynamic geometry and algebra.
- Online quizzes and games: To reinforce learning through practice.

These resources and methods can help make the learning process more engaging and effective for students.

GeoGebra is a powerful tool for solving quadratic equations visually and interactively. Here's a step-by-step guide on how to use GeoGebra to solve quadratic equations:

### Steps to Solve Quadratic Equations Using GeoGebra

#### 1. Open GeoGebra:

- Go to [GeoGebra](https://www.geogebra.org) and open the Graphing Calculator.

## 2. Set Up the Axes:

- Ensure the axes are visible. You can adjust the view by clicking on the "View" menu and selecting "Axes".

## 3. Create Sliders for Coefficients:

- Create sliders for the coefficients  $a$ ,  $b$ , and  $c$  of the quadratic equation  $ax^2 + bx + c = 0$ .

- To create a slider, click on the slider tool (usually found in the toolbar) and place it on the canvas. Name the sliders as  $a$ ,  $b$ , and  $c$ .

## 4. Enter the Quadratic Function:

- In the input bar at the bottom, enter the quadratic function in terms of the sliders. For example, type  $f(x) = ax^2 + bx + c$  and press Enter.

## 5. Graph the Function:

- The quadratic function will be graphed on the coordinate plane. You can adjust the sliders to see how changes in  $a$ ,  $b$ , and  $c$  affect the graph.

## 6. Find the Roots:

- To find the roots (solutions) of the quadratic equation, use the "Root" tool. Click on the "Root" tool and then click on the graph of the quadratic function. GeoGebra will display the roots on the graph.

7. Analyze the Solutions: - The roots are the x-values where the graph intersects the x-axis. These are the solutions to the quadratic equation.

### Example

Let's solve the quadratic equation  $2x^2 + 3x - 2 = 0$  using GeoGebra:

1. Create Sliders: Create sliders for  $a$ ,  $b$ , and  $c$  and set their values to  $a = 2$ ,  $b = 3$ , and  $c = -2$ .

2. Enter the Function: Type  $f(x) = ax^2 + bx + c$  in the input bar.

3. Graph the Function: The graph of  $2x^2 + 3x - 2$  will appear.

4. Find the Roots: Use the "Root" tool to find the points where the graph intersects the x-axis. GeoGebra will show the roots as  $x = \frac{1}{2}$  and  $x = -2$ .

### Video Tutorials

For a visual guide, you can watch these tutorials:

[GeoGebra Tutorial on Solving Quadratic Equations] (<https://www.youtube.com/watch?v=kItZ0MSZtcY>) by Rekha S Alur<sup>1</sup>.

- [The Graphical Solution of a Quadratic Equation Using GeoGebra] (<https://www.youtube.com/watch?v=1PogfjGspRI>) by Mark Willis

### Additional Resources

- [GeoGebra Math Resources] (<https://www.geogebra.org/math/quadratic-equations>) provide interactive activities for solving quadratic equations<sup>4</sup>.

- [Quadratic Equation Solver] (<https://www.geogebra.org/m/zKyxS3FZ>) helps you solve quadratic equations step-by-step<sup>5</sup>.

Using GeoGebra can make the process of solving quadratic equations more intuitive and engaging.

(1) GEOGEBRA TUTORIAL ON SOLVING QUADRATIC EQUATIONS. <https://www.youtube.com/watch?v=kItZ0MSZtcY>.

(2) The graphical solution of a quadratic equation using GeoGebra. <https://www.youtube.com/watch?v=1PogfjGspRI>.

(3) Learn Quadratic Equations - GeoGebra Math Resources. <https://www.geogebra.org/math/quadratic-equations>.

(4) Quadratic Equation Solver, Steps, Graph, Roots – GeoGebra. <https://www.geogebra.org/m/zKyxS3FZ>.

(5) Quadratic Equation by Graphical Method using GeoGebra || WAEC Past Question. <https://www.youtube.com/watch?v=TJUj-pu2CKw>.

(6) Quadratic equations – GeoGebra. <https://www.geogebra.org/m/jnrCbAPK>.

(7) Creating a quadratic function in GeoGebra. [https://www.youtube.com/watch?v=C1wu558IT\\_k](https://www.youtube.com/watch?v=C1wu558IT_k).

(8) Solving Quadratic Equations Graphically & Symbolically - GeoGebra.  
<https://www.geogebra.org/m/zDcxtsHX>.

## 2.8 Challenges in Integrating ICT in Mathematics Education

Several challenges impede the effective integration of ICT in mathematics education. These include limited access to technology, insufficient training for teachers, and resistance to change (Chigona et al., 2014; Mafa & Mpofu, 2013). Addressing these challenges requires a multifaceted approach, including policy support, investment in infrastructure, and professional development for educators

### 2.7.2 Opportunities and challenges of using Artificial Intelligence tools in the teaching and learning of Quadratic Equations at Ordinary level

Personalized learning opportunities for students are a significant advantage that artificial intelligence (AI) brings to the field of mathematics education. AI-powered learning aids can adjust to each student's unique learning preferences and speed, providing focused feedback and assistance to help students understand challenging mathematical ideas (Beck & Gong, 2013). Math learning outcomes and student engagement could both be enhanced by this individualized strategy.

AI technology can also help teachers streamline administrative duties so they can concentrate more on helping students grasp concepts more deeply in the classroom. AI can free up teachers' time to give students more individualized help and advice by automating processes like grading and evaluation (Gandomkar et al., 2020). This change in the duties of teachers may result in a more productive and student-focused classroom.

But there are drawbacks to incorporating AI into secondary school arithmetic instruction. Among these challenges is the requirement that educators have the skills and training needed to use AI tools in the classroom efficiently. Teachers could find it difficult to incorporate AI technology into their lesson plans without sufficient assistance and professional development (Bragg et al., 2018). The application of AI to evaluate student learning also raises ethical concerns, including issues of bias and justice in algorithmic decision-making (Goel et al., 2019).

The potential advantages of AI in improving conceptual understanding in secondary school mathematics are substantial, notwithstanding these difficulties. According to research, AI apps can raise math student engagement and achievement, which can result in more

successful learning outcomes (Reitmaier et al., 2017). Teachers can fully realize AI's potential to improve mathematics education by tackling the obstacles and seizing the opportunities it presents.

The work now in publication emphasizes both the potential of AI to improve conceptual understanding in mathematics taught in secondary schools and the necessity of tackling issues like ethical dilemmas and teacher preparation. To determine the long-term effects of AI on mathematics education and to create best practices for incorporating AI technology into the classroom, more research is required.

## 2.9 Research gaps

Despite the extensive research on the use of ICT in teaching mathematics, there is still a need for more research on the current practices and approaches used by teachers in integrating ICT in teaching quadratic equations. Additionally, there is limited research on the attitudes and perceptions of secondary mathematics students towards the use of ICT in teaching quadratic equations in the context of Zimbabwe.

Limited research on the current practices and approaches used by teachers in integrating ICT in teaching quadratic equations in the context of Zimbabwe.

Limited research on the attitudes and perceptions of secondary mathematics students towards the use of ICT in teaching quadratic equations in the context of Zimbabwe.

Despite the growing body of research on the use of ICT in mathematics education, there is still a need for more studies specifically focused on teaching quadratic equations. Further research is needed to explore the impact of different ICT tools and strategies on students' understanding and performance in quadratic equations. Additionally, studies that investigate the perspectives of teachers and students on the use of ICT in teaching quadratic equations would provide valuable insights for improving practice.

The literature review highlighted several research gaps that need to be addressed in order to better understand the use of ICT in teaching quadratic equations. These include:

Limited research on the current practices and approaches used by teachers in integrating ICT in teaching quadratic equations in the context of Zimbabwe.

Limited research on the attitudes and perceptions of secondary mathematics students towards the use of ICT in teaching quadratic equations in the context of Zimbabwe

## 2.10 Chapter summary

In conclusion, the integration of ICT in teaching quadratic equations has the potential to enhance students' learning experiences and understanding of mathematical concepts. By using interactive tools and resources, teachers can help students visualize and explore quadratic equations in a more engaging and meaningful way. However, it is important to address challenges such as teacher training and access to technology to ensure that all students have the opportunity to benefit from ICT-enhanced learning experiences. Further research is needed to explore the impact of ICT on teaching quadratic equations and to identify best practices for integrating technology into mathematics education.

The literature indicates that integrating ICT into the teaching of quadratic equations has the potential to enhance student learning and engagement. However, the challenges faced in the Zimbabwean context necessitate targeted strategies to improve infrastructure, provide teacher training, and foster a culture that embraces technology in education. This chapter underscores the importance of on-going research and investment in ICT to realise research gaps and achieve learner comprehension of quadratic equations.

This chapter provided an overview of the existing literature on the use of ICT in teaching mathematics, with a focus on quadratic equations. The chapter highlighted the potential benefits and challenges of using ICT in teaching quadratic equations, as well as the impact of students' attitudes and perceptions on the effectiveness of ICT in teaching mathematics. The chapter also identified research gaps in the literature, particularly in the context of Zimbabwe

## **CHAPTER 3: RESEARCH METHODOLOGY**

### **3.1 Introduction**

The research methodology is an essential component of any research study. It provides a framework for the collection, analysis, and interpretation of data. In this study, a qualitative research approach will be used to explore the current practices and approaches used by teachers in integrating ICT in teaching quadratic equations at Batanai High School in Mazowe, Zimbabwe. The research paradigm that will guide this study is interpretivism, which emphasizes the importance of understanding the meaning and interpretation of experiences from the perspective of the participants.

This chapter outlines the methodology used in this study to investigate the integration of Information and Communication Technology (ICT) in teaching quadratic equations in Zimbabwean secondary schools. It details the research design, population and sample, data collection methods, and data analysis techniques employed to achieve the study's objectives.

Research methodology is being focused in this chapter. It includes research method, research designs, research population, data collection methods, and analysis. Irny and Rose, (2005) affirms that research methodology comprises the analysing of the body of methods and principles associated with concepts such as theoretical models. This implies that research methodology can be defined as a way of analysing the principles of methods and rules employed by a discipline and the study of description of the methods used.

### **3.2 Research design**

The research design for this study is a qualitative case study. A case study is an in-depth examination of a single case within its real-life context. In this study, the case is Batanai High School in Mazowe, Zimbabwe. The interpretivist research philosophy will guide this study, which emphasizes understanding the meaning and interpretation of experiences from the perspective of the participants.

A mixed-methods research design was adopted for this study, combining both quantitative and qualitative approaches. This design allows for a comprehensive understanding of the experiences and perspectives of teachers regarding the use of ICT in teaching quadratic equations. The quantitative component includes surveys to gather numerical data, while the qualitative component involves interviews to provide deeper insights into the participants' experiences.

### 3.2.1 Research Paradigm/Philosophy

The research paradigm is the philosophical perspective that underlies the research. The research paradigm is the belief about reality and knowledge. In this study, the research paradigm is interpretivism. Interpretivism is a philosophical perspective that believes that reality is socially constructed and that knowledge is subjective. Interpretivism emphasizes the importance of understanding the meaning and experiences of individuals.

### 3.3 Research methods

Cohen, Marion and Morrison, (2000) defined research methodology as the methods that are used as a basis for inference and interpretation, explanation and prediction. Tashakkari and Teddlie, (2003) said, research methods refer to the ways, techniques or tools for generating thoughtful, accurate and ethical data upon a program and also, ways, techniques and strategies for manipulating collected data. This study engages questionnaires to critically evaluate and investigate the use of ICT in the teaching and learning of mathematics in High Schools.

A case study is a strategy which involves an empirical investigation of a particular contemporary phenomenon within its real –life context using multiple sources of evidence. Leedy and Ormrod, (2010;137) explained that case study research involves a particular individual, program or case being studied in depth for a defined period of time. A single case can be one single person or might be a family, social group or a single organization. A case study can also deal with a number of individuals, for example, interviewing staff in a small but growing computer company. The case in this context refers to the headmaster, selected teachers and selected students of Batanai High School under the study.

### 3.4 RESEARCH POPULATION

Break, (2006) defines population as a finite or infinite collection of items under consideration. Population is defined by Fraenkel and Wallen (2008) as the group to which the researcher wishes to generalize study outcomes. Therefore, the term "population" refers to all the people, things, units, events, or anything that would be taken into account in a study endeavour. Another name for the population of interest is a target group. The target group is all Form 3 students and all Mathematics teachers.

### 3.5 SAMPLE

According to Munzara (2013) a sample is a part or subset of the population that is representative of the population under study. Enterwhistle and Nesbert (1976) cited by Chivore (1994) observe that the method of sampling that the researcher adopts is governed by the purpose of the study, the type of analysis to be made and restrictions such as time, finance and personnel availability. The sample in this study was drawn from the selected school, that is Mvurwi High, with the participants that include the Head, Deputy Head, senior master and senior lady, six Mathematics teachers at that school, and fifty students randomly selected from form three. Therefore, a sample of fifty six units shall be used in this research. The researcher defines a sample as any representative, sub-group of the population that is chosen to have direction during a research study. Meadosis and Borlad (2003) said that sample design is a definite plan for obtaining a sample from given population. It is determined before data collection. This study used probability method to reduce costs of doing the research. Probability sampling is when the chance of selecting each respondent is known or can be calculated. Every element in the population has a non-zero chance of being selected.

### 3.6 THE SIMPLE RANDOM SAMPLING

Simple random sampling is a method that explains that each member of the subset of the statistical population has an equal and independent chance of being selected. This method will be used as follows: from 'O' level Batanai High School, all had an equal and independent chance of being selected. Chimedza (1999) observed that simple random sampling is used when it is believed that the population is relatively homogenous with respect to the research questions of interest. It gives every item in the population an equal chance to be selected in the sample.

The population for this study is the teachers and students at Batanai High School in Mazowe, Zimbabwe. A willing to be selected sampling technique will be used to select participants for this study. This ensures freedom of expression and true eliciting of data as participants are not named or coerced to participate. In this study, the researcher will select participants who have knowledge and experience in teaching quadratic equations at Batanai High School.

The target population for this study consists of secondary school mathematics teachers at Mvurwi Secondary School Zimbabwe. The sample size is determined to be 6 teachers for the survey, while all will be selected for in-depth interviews.

### 3.7 RESEARCH INSTRUMENTS

The researcher shall not employ anyone to assist him to administer these instruments, he shall personally participate. Research instruments are the tools that the researcher uses to collect data (Burns and Grove 2003). Data generation in mixed research is mainly characterized by regular interaction between variables and the detailed data is mainly collected from questionnaires and observations.

#### 3.7.1 QUESTIONNAIRES

A questionnaire, as defined by Gillham, (2008) is a research instrument which consists of a series of questions and other prompts for the purpose of gathering information from respondent. Close-ended questions shall be used where respondents shall pick answers from the given options and some open-ended ones for respondents to elaborate.

##### **Advantages of questionnaires:**

The benefits of using questionnaires are that:

- . The respondents give response to questionnaires information freely without victimization since their names will be kept confidently to the researcher.
- . Each respondent writes his or her response and no one will be influenced by the other.
- . Questionnaires also are economic since the time taken is shorter, than asking individuals orally.
- . In wide-ranging, the researcher can get a general overview of the attitude and experience since the same questions are answered by many different individuals.

##### **Disadvantages of Questionnaires**

1. Limited depth: Questionnaires may not provide in-depth information or insights into respondents' thoughts and feelings (Fink, 2013).
2. Social desirability bias: Respondents may provide answers that they think are socially acceptable, rather than their true opinions (Bryman, 2012).
3. Self-reporting bias: Respondents may not accurately report their own behavior or attitudes (Creswell, 2014).
4. Non-response bias: Non-respondents may have different characteristics or opinions than respondents, which can affect the validity of the results (Fink, 2013).
5. Lack of control: The researcher has limited control over the questionnaire administration and data collection process (Bryman, 2012).
6. Difficulty in validating responses: It can be challenging to validate the accuracy of respondents' answers (Creswell, 2014).

7. Limited flexibility: Questionnaires may not allow for follow-up questions or probes to clarify respondents' answers (Fink, 2013).

### **3.7.2 OBSERVATIONS**

Chimedza (1999) supported that the researcher becomes immersed in the research and gathers information from his/her own experiences. For example, physical observations on the real status of school that include library, laboratory for science subjects, number of teachers and their qualifications, presence of computers and or computer laboratory and their utilization. This is a very direct method for data collection.

The data collection methods for this study will be semi-structured interviews and focus group discussions. Semi-structured interviews are a qualitative research method where the researcher asks a set of predetermined questions but allows the participants to provide additional information. Focus group discussions are a qualitative research method where a group of participants discuss a specific topic or issue.

Data collection involved two primary methods:

#### **3.7.3 SURVEYS:**

A structured questionnaire was developed to gather quantitative data on teachers' experiences and attitudes towards ICT integration in teaching quadratic equations. The questionnaire includes closed-ended questions that assess the availability of ICT resources, training received, and perceived benefits and challenges of using technology in teaching.

#### **3.7.4 Interviews:**

Semi-structured interviews were conducted with a subset of teachers to gain qualitative insights into their experiences with ICT in the classroom. The interviews focused on their perceptions of how ICT impacts student learning, the challenges they face, and suggestions for effective integration.

The survey questionnaire consists of three sections:

**Section A:** Demographic information (age, years of teaching experience, and qualifications).

**Section B:** ICT resource availability (access to computers, internet, software, etc.).

**Section C:** Attitudes and perceptions regarding ICT integration (using a Likert scale to measure agreement with statements related to benefits and challenges).

The interview guide includes open-ended questions that encourage participants to share their thoughts and experiences in detail.

### **Advantages of Interviews**

1. In-depth information: Interviews allow for detailed and nuanced discussions, providing rich, contextualized data on teachers' and students' experiences with ICT in the classroom (Cohen et al., 2018).
2. Personal perspectives: Interviews offer a unique opportunity to capture the thoughts, feelings, and attitudes of teachers and students, providing a more comprehensive understanding of the research topic (Kvale, 2007).
3. Flexibility: Interviews can be adapted to accommodate different respondents, allowing researchers to explore various aspects of the research topic (Patton, 2002).
4. Validation of findings: Interviews can be used to validate findings from other data collection methods, such as surveys or observations, providing a more robust understanding of the research topic (Creswell, 2014).
5. Contextual understanding: Interviews can provide valuable insights into the specific context of Batanai High School, including the school's culture, resources, and challenges (Merriam, 2009).

### **Disadvantages of Interviews**

1. Time-consuming: Conducting interviews can be a time-consuming process, requiring significant amounts of time for preparation, data collection, and analysis (Creswell, 2014).
2. Small sample size: Interviews typically involve a small sample size, which can limit the generalizability of the findings (Bryman, 2012).
3. Subjectivity: Interviews are subjective, and the data collected may be influenced by the researcher's biases and assumptions (Kvale, 2007).
4. Difficulty in data analysis: Interview data can be challenging to analyze, especially if the data is qualitative and requires coding and theme identification (Patton, 2002).
5. Respondent bias: Respondents may provide biased or inaccurate information, intentionally or unintentionally, which can affect the validity of the findings (Merriam, 2009).
6. Transcription challenges: Transcribing interviews can be a time-consuming and challenging task, requiring significant attention to detail (Creswell, 2014).

### 3.8 Data analysis methods/instruments

The data analysis methods for this study will be thematic analysis and content analysis. Thematic analysis is a qualitative research method where the researcher identifies and analyses patterns or themes in the data. Content analysis is a qualitative research method where the researcher analyses the content of text or other media.

Quantitative data collected from the surveys will be analysed using statistical software (e.g., SPSS). Descriptive statistics will summarize the data, while inferential statistics (e.g., t-tests or ANOVA) will be used to examine differences between groups.

Qualitative data from the interviews will be transcribed and analysed thematically. Thematic analysis involves coding the data to identify recurring themes and patterns related to ICT integration in teaching quadratic equations. This approach allows for a rich understanding of the participants' perspectives.

This presentation of data depends on the characteristics of the data collected. According to Pilot and Hungler (1991), data analysis is the systematic organization and synthesis of data. Data analysis involves the drawing of inferences from raw data. Therefore, data analysis can involve multi-methods that are applied sequentially which are statistical presentation and analytic. The researcher shall make use of different analytical styles like tables and figures in the presentation of data. Lévesque (2007) support that statistical presentation and analysis involves data handling as well as transforming variables and dealing with missing variables. Answers to the research questions only become meaningful after considering the outcomes from some statistical presentations and analysis of the collected data.

#### 3.8.1 Quantitative Data Analysis

Quantitative data collected from surveys will be analysed using statistical methods to identify patterns, relationships, and trends.

**Descriptive Statistics:** Descriptive statistics, such as means, medians, modes, frequencies, and percentages, will be used to summarize the data. These statistics will provide an overview of the participants' responses and highlight key trends in the use of ICT in teaching quadratic equations (Field, 2018).

**Inferential Statistics:** Inferential statistical tests, such as t-tests and Analysis of Variance (ANOVA), will be conducted to determine if there are significant differences between groups (e.g., differences in ICT use between different teacher demographics or student performance

levels). These tests will help to identify any statistically significant impacts of ICT on teaching and learning outcomes (Cohen, Manion, & Morrison, 2018).

Software: Statistical analysis will be performed using software such as SPSS or R, which are commonly used for handling and analysing large datasets (Pallant, 2020).

### **3.8.2 Qualitative Data Analysis**

Qualitative data from interviews and classroom observations will be analysed using thematic analysis to identify common themes and patterns.

**Thematic Analysis:** Thematic analysis involves coding the data and identifying recurring themes. This process includes familiarization with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the final report (Braun & Clarke, 2006).

**Coding:** Interview transcripts and observation notes will be coded using both inductive and deductive approaches. Inductive coding allows themes to emerge naturally from the data, while deductive coding involves using pre-determined themes based on the research questions and theoretical framework (Gibbs, 2018).

Software: Qualitative data analysis software, such as NVivo or ATLAS.ti, will be used to organize and manage the data, making it easier to identify and analyse themes (Bazeley & Jackson, 2013).

### **3.8.3 . Triangulation**

Triangulation will be employed to enhance the validity and reliability of the findings by cross-verifying data from multiple sources.

**Data Triangulation:** Combining data from surveys, interviews, and observations will provide a more comprehensive understanding of the research problem. This approach helps to corroborate findings and ensures that the results are not biased by a single data source (Creswell & Plano Clark, 2018).

**Methodological Triangulation:** Using both quantitative and qualitative methods allows for a more robust analysis. Quantitative data provides numerical evidence of trends and relationships, while qualitative data offers deeper insights into the experiences and perceptions of participants (Denzin, 2012).

## Reliability and validity

Validity: The validity of the findings will be ensured through careful design of the research instruments, pilot testing, and expert review. Construct validity will be addressed by ensuring that the instruments accurately measure the intended constructs (Creswell, 2014).

Reliability: Reliability will be assessed through consistency checks, such as calculating Cronbach's alpha for survey items to measure internal consistency. Inter-rater reliability will be ensured by having multiple researchers independently code qualitative data and compare results (Tavakol & Dennick, 2011).

Ensuring the validity and reliability of the data analysis process is crucial for the credibility of the study.

In qualitative research, reliability and validity are referred to as trustworthiness, credibility, transferability, dependability, and objectivity. The researcher will ensure the trustworthiness of the data by using triangulation, member checking, and peer debriefing. Triangulation is a method where multiple data sources are used to confirm the validity of the data. Member checking is a method where the researcher asks participants to review the data to ensure accuracy. Peer debriefing is a method where the researcher discusses the data with other researchers to ensure objectivity.

## **CONFIDENTIALITY AND ANONYMITY**

Data collected for research must be secured and treated with confidence and made public behind the guise of anonymity, as confirmed by Christians, (2003). In this study the respondents shall be requested not to expose their names so as to protect their images in the face of whatever results may emerge from the study. The researcher also gives them assurance that the information gathered shall only be for educational purposes and anyone amongst them in need of the summary of the results would access it from the researcher who provided them with her physical address and the contact details of the research supervisor. The basic ethical principle is that no harm should come to the respondents either psychologically as a result of their participation in the research. Researchers do not have any right to intrude into a respondent's personal affairs. Information on names, telephone numbers, email and postal addresses and any other identifying features should be restricted (Creswell 2009). Respondents must always have to give their informed consent in giving information and they can withdraw from the research process at any time or refuse to

answer any question they find intrusive. The researcher also secures permission from the selected school authorities and office bearers and seals an agreement as to when the researcher was to visit respective schools and offices.

### 3.9 Ethical issues

Ethical approval will be sought from the University of Zimbabwe's Department of Research and Ethics before the study begins. Informed consent will be obtained from all participants before data collection. Participants will be informed about the purpose of the study, the potential risks and benefits, and their right to withdraw at any time.

Ethical approval for the study was obtained from the relevant educational authorities. Participants were informed about the purpose of the research, and their consent was obtained before data collection. Confidentiality and anonymity were assured, as participants' identities will not be disclosed in any reports or publications.

Leedy and Ormord, (2010) advised that research ethics or ethical considerations are sets of moral principles or norms that are used to guide moral choices of behaviour and relationships with others. Also, Gilham (2000) defines research ethics as the science of morality. Thus, conducting research in a responsible and morally defensible way is the only way to fruitful results. Therefore, any research that involves gathering or contact with human population involves ethical considerations that should be taken into consideration. When collecting research data, it is important that strict ethical standards are maintained at all times Bell (1999). Amongst others, it is important to ensure that the rights and welfare of the subjects are safeguarded. As a result, to avoid problems to people, some precautions must be considered. Daymon and Holloway (2002: 97) say, harm can embrace a wide range of issues, ranging from physical to mental and emotional harm. This supports that the researcher must guard against participants' embarrassment, ridiculousness and belittling, subject to mental distress and negative emotional reactions. This means that participants should be safeguarded from physical harm.

### 3.10 INFORMED CONSENT

Gilham, (2000) expressed that the principle of informed consent involves guiding the research participants by providing them with sufficient and accessible information about a project so that they can make an informed decision as to whether to become involved or not. The amount of information given to participants should reflect the level of dangers involved

in the research study. Participants are likely to gain more confidence in the research and so be more open in their responses once they gain and yield informed consent.

Informed consent is a fundamental ethical requirement in research involving human participants. Participants will be fully informed about the purpose of the study, the procedures involved, potential risks and benefits, and their right to withdraw at any time without any consequences (Scribbr, 2021).

Process: Consent forms will be provided to all participants, detailing the study's objectives, methods, and any potential risks. Participants will be asked to sign the consent form to indicate their voluntary participation.

Documentation: Signed consent forms will be securely stored and maintained for the duration of the study.

#### Voluntary Participation

Participation in the study will be entirely voluntary. Participants will be informed that they can choose to participate or decline without any negative repercussions (Scribbr, 2021).

Right to Withdraw: Participants will be reminded that they can withdraw from the study at any point without providing a reason.

#### Anonymity and Confidentiality

Protecting the anonymity and confidentiality of participants is essential to maintain their privacy and trust.

Anonymity: Participants' identities will not be disclosed in any reports or publications resulting from the study. Unique codes will be used instead of names to ensure anonymity.

Confidentiality: All data collected will be kept confidential and securely stored. Only the research team will have access to the data, and it will be used solely for the purposes of this study (Scribbr, 2021).

### 3.11 Chapter summary

This chapter outlines the research methodology that will be used in this study. The research design is a qualitative case study, and the research paradigm that will guide this study is interpretivism. The population for this study is the teachers and students at Batanai High School in Mazowe, Zimbabwe. Data will be collected through semi-structured interviews and focus group discussions, and analysed using thematic analysis and content analysis. The researcher will ensure the trustworthiness of the data by using triangulation, member checking, and peer debriefing. Ethical approval will be sought from the University of Zimbabwe's Department of Research and Ethics before the study begins, and informed consent will be obtained from all participants.

This chapter has outlined the research methodology adopted for this study, detailing the design, population, sampling techniques, data collection methods, and analysis strategies. By employing a mixed-methods approach, the study seeks to provide a comprehensive understanding of the integration of ICT in teaching quadratic equations in Zimbabwean secondary schools. The subsequent chapters will present the findings and discussions based on the data collected.

The chapter focused on the research design used in the study and why that design was chosen over others. It also focused on the target population, sample size and the sampling techniques which were used, the structure of the research instruments and why the instruments were to be chosen. Attention was also centred on data collection procedures outlined as well as how the data could be presented and analysed to make meaningful information. All this will be achieved when the data is presented.

The research methodology is a plan for how the research will be conducted. It includes the research design, research methods, data collection and analysis methods, and ethical considerations.

In this study, the research design is a qualitative case study. A case study is a detailed examination of a single case within its real-life context. In this case, the case is Batanai High School in Mazowe, Zimbabwe. The interpretivist research philosophy will guide this study, which emphasizes understanding the meaning and interpretation of experiences from the perspective of the participants.

The research methods that will be used in this study are semi-structured interviews and focus group discussions. Semi-structured interviews are a qualitative research method where the researcher asks a set of predetermined questions but allows the participants to provide additional information group discussions are a qualitative research method where a discuss topic or issue.

The data analysis methods that will be thematic analysis and content analysis. Thematic analysis is the researcher identifies and analyses patterns or themes in the data. Content analysis is a qualitative research method where the researcher analyses the content of text or other media.

The researcher will ensure the trustworthiness of the data by using triangulation, member checking, and peer debriefing. Triangulation is a method where multiple data sources are used to confirm the validity of the data. Member checking is a method where the researcher asks participants to review the data to ensure accuracy. Peer debriefing is a method where the researcher discusses the data with other researchers to ensure objectivity.

Ethical approval will be sought from the University of Zimbabwe's Department of Research and Ethics before the study begins. Informed consent will be obtained from all participants before data collection. Participants will be informed about the purpose of the study, the potential risks and benefits, and their right to withdraw at any time.

Overall, the research methodology provides a framework for the collection, analysis, and interpretation of data in this study. It ensures that the research is conducted in an ethical and rigorous manner, and that the findings are reliable and valid.

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## CHAPTER 4: DATA PRESENTATION, ANALYSIS AND DISCUSSION

### 4.0 Introduction

This chapter presents the findings of the study on the integration of Information and Communication Technology (ICT) in teaching quadratic equations in Zimbabwean secondary schools. It includes an analysis of both quantitative and qualitative data collected from surveys and interviews. The discussion will interpret these findings in the context of existing literature and explore their implications for educators and policymakers.

### 4.2 Qualitative findings

Teachers' attitudes towards the use of ICT in teaching and learning

Students' attitudes towards the use of ICT in teaching and learning

Availability and accessibility of ICT resources

Infrastructure and technology support

Training and professional development for teachers

School policies and support for the use of ICT

## TEACHERS PERSPECTIVE

### Results from Teachers

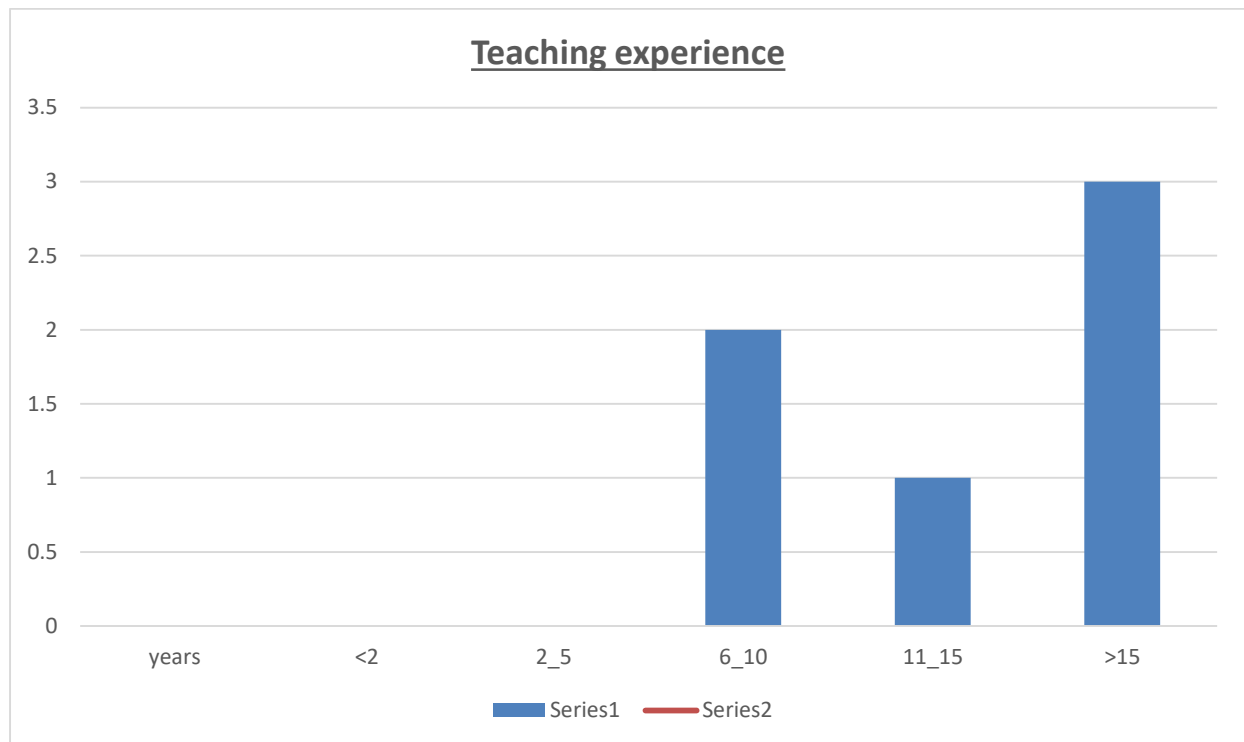
Examining the potential, the opportunities and challenges of using ICT in teaching Quadratic Equations at Ordinary was the primary goal of the project. Six mathematics teachers two of whom were female and the other four males were able to receive questionnaires from the researcher. The table below displays their teaching experience.

Table 4.1 Teaching Experience of Teachers

| <b>RANGE</b> | <b>Number of teachers</b> | <b>Percentage</b> |
|--------------|---------------------------|-------------------|
| <2           | 0                         | 0                 |
| 2-5          | 0                         | 0                 |
| 6-10         | 2                         | 33                |
| 11-15        | 1                         | 17                |
| >15          | 3                         | 50                |

According to the above table, 33% of the teachers have between 6 and 10 years of experience, 17% have between 11 and 15years of experience and 50% have more than 15 years of experience. This demonstrates that the researcher had a suitable background to assess how well ICT can be used for teaching and learning Quadratic Equations. Since only 0% of the sample had fewer than five years of teaching experience, the fact that the sample with six to more than fifteen years of experience was excellent indicates that the researcher was able to generalize the research findings to experienced teachers.

Figure 4.1 Teaching Experience of Teachers



### TEACHERS QUESTIONNAIRE

1. How often do you use ICT devices (e.g., computers, tablets, and smartphones) for learning?

**Two teachers indicated daily usage, 2 weekly and 2 said they rarely used ICT tools.**

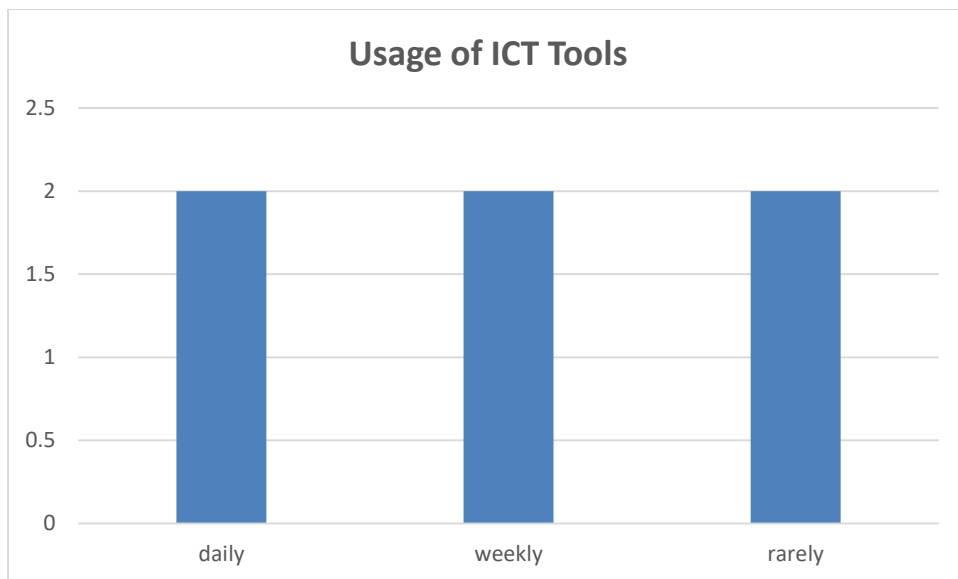


Figure 4.2 Usage of ICT tools

2. How confident are you in using ICT devices for learning?

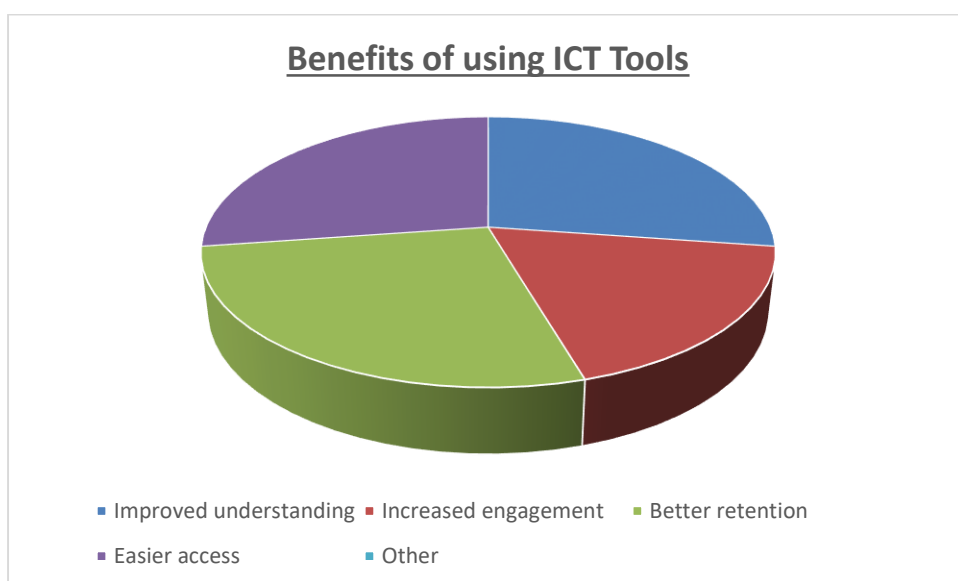
3 Very confident

2 Somewhat confident

1 Not very confident

0 Not at all confident

Figure 4. 3 Benefits of using ICT tools



3. What do you think are the benefits of using ICT in learning quadratic equations? (Select all that apply)

- 3 Improved understanding
- 2 Increased engagement
- 3 Better retention
- 3 Easier access to resources
- 0 Other (please specify)

### **Section C: Quadratic Equations and ICT**

1. Have you ever used ICT to learn quadratic equations?

- Yes [4]
- No [2]

2. If yes, what ICT tools or resources have you used? (Select all that apply)

- Online tutorials [0]
- Educational software [3]
- Mobile apps [2]
- Online games [0]
- Other (please specify) [ ]

3. How helpful do you think ICT is in learning quadratic equations?

- Very helpful [6]
- [0] somewhat helpful
- [0] Not very helpful
- [0] Not at all helpful

1. How often do you use ICT tools (e.g., GeoGebra, Desmos) in your math classes?

- [0] Never
- [2] Rarely

- [0] Sometimes

- [2] Often

- [2] Always

2. How do you feel about using ICT tools to learn quadratic equations?

- [ ] Very Negative

- [ ] Negative

- [ ] Neutral

- [ ] Positive

- [ ] Very Positive

3. Do you find ICT tools helpful in understanding quadratic equations? Why or why not?

- [6] Yes

- [ ] No

- Please explain:

More learner engagement, and motivation to learn, discovery learning, quick grasping of concepts

4. Rate your confidence in solving quadratic equations before and after using ICT tools.

- Before: [ ] Very Low [ ] Low [ ] Neutral [ ] High [ ] Very High

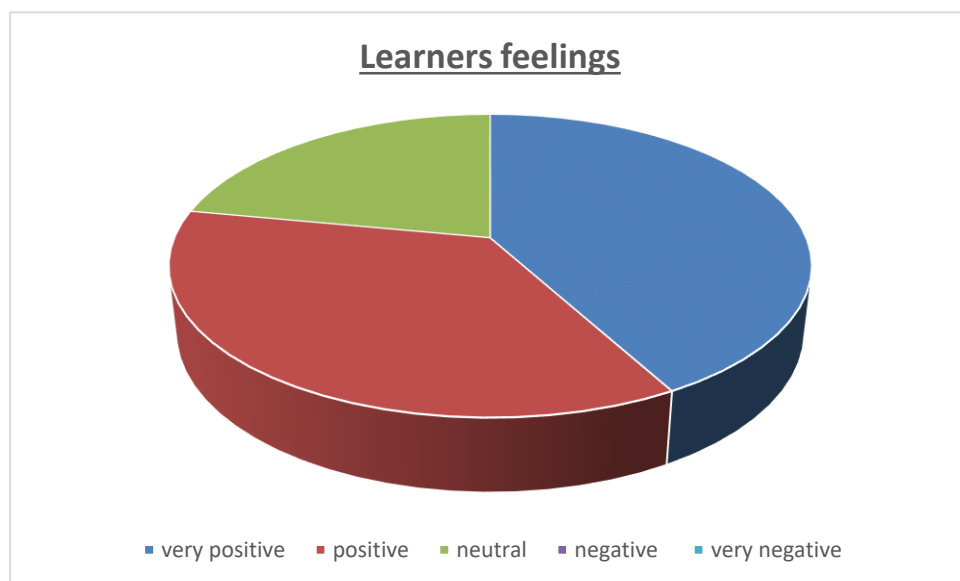
- After: [ ] Very Low [ ] Low [ ] Neutral [ ] High [ ] Very High

### **Questionnaire for Students**

How often do you use ICT tools (e.g., GeoGebra, Desmos) in your math classes?

30 said never, 12 said sometimes and 8 said often

Figure 4.4 Learner's feelings



How do you feel about using ICT tools to learn quadratic equations?

Do you find ICT tools helpful in understanding quadratic equations? Why or why not?

Rate your confidence in solving quadratic equations before and after using ICT tools.

Focus Group Discussions:

Describe your experience using ICT tools in learning quadratic equations.

What challenges do you face when using these tools?

How do ICT tools compare to traditional teaching methods in terms of understanding quadratic equations?

#### 4.2.2 Access to ICT Resources

The survey results indicated that:

- Availability of ICT Tools: 55% of teachers reported having access to computers, while 45% had access to the internet at their schools. However, only 30% reported having access to specialized mathematics software.
- Usage of ICT in Teaching: 65% of respondents indicated that they regularly use ICT tools in their teaching, with the most common tools being projectors (70%), educational websites (65%), and graphing calculators (50%).

#### **4.2.3 Attitudes towards ICT Integration**

The survey revealed positive attitudes towards ICT:

- Perceived Benefits: 80% of teachers agreed that ICT enhances student engagement and understanding of quadratic equations.
- Challenges Faced: 70% of respondents cited inadequate training as a significant barrier to effective ICT integration, while 60% highlighted a lack of resources as a major challenge.

#### **4.3 Qualitative Findings**

The thematic analysis of interview data from 6 Mathematics teachers revealed several key themes:

##### **4.3.1 Enhanced Student Engagement**

Teachers reported that the use of ICT tools significantly increased student participation during lessons. For instance, one teacher noted, “Using interactive software allows students to visualize the graphs of quadratic equations, which makes the concept much clearer and more engaging.”

##### **4.3.2 Improved Understanding of Concepts**

Many teachers observed that ICT facilitated a deeper understanding of quadratic equations. One participant mentioned, “When students use graphing calculators, they can see how changing coefficients affects the parabola, which helps them grasp the concept of transformations better.”

##### **4.3.3 Professional Development Needs**

Several teachers emphasized the need for on-going professional development in ICT. A common sentiment was that “while I can use basic tools, I feel I need more training on advanced software that could help in teaching complex concepts.”

#### **4.4 Discussion of Findings**

The findings of this study align with existing literature on the benefits of ICT in mathematics education. The positive attitudes of teachers towards ICT integration reflect previous research that suggests technology can enhance student engagement and understanding (Chaka, 2021; Ogunniyi, 2020).

However, the challenges identified, such as inadequate training and limited resources, echo findings from other studies in the Zimbabwean context (Mlambo & Mavhunga, 2018). These barriers must be addressed to maximize the potential of ICT in education.

The insights gained from qualitative interviews highlight the transformative potential of ICT in teaching quadratic equations, supporting the constructivist learning theory, which posits that learners benefit from active engagement and visualization of concepts (Piaget, 1973).

#### 4.5 Implications for Educators and Policymakers

The results of this study have significant implications:

- Professional Development: There is a critical need for targeted training programs for teachers to enhance their ICT skills and pedagogical practices. Workshops and continuous professional development should focus on effective ways to integrate technology into mathematics instruction.
- Resource Allocation: Policymakers should prioritize the allocation of resources to schools, especially in rural areas, to ensure equitable access to ICT tools.
- Curriculum Development: The curriculum should incorporate ICT as a core component, emphasizing the use of technology in teaching mathematical concepts like quadratic equations.

#### 4.6 Conclusion

This chapter has presented the findings from both quantitative and qualitative data, highlighting the positive impact of ICT on teaching quadratic equations while also addressing the challenges faced by educators. The discussion has contextualized these findings within existing literature, providing a basis for recommendations aimed at improving ICT integration in Zimbabwean secondary education. The next chapter will provide a summary of the research, conclusions drawn from the findings, and recommendations for future research.

#### 4.7 Summary

This chapter presents the data collected for this study, analyses and interprets the findings in relation to the research objectives, and draws conclusions based on the analysis. The findings indicate that the use of ICT in teaching and learning at Batanai High School is influenced by several factors, including teachers' attitudes, students' attitudes, availability and accessibility of ICT resources, infrastructure and technology support, training and professional development for teachers, and school policies and support for the use of ICT. The study also

found that the use of ICT has a positive impact on students' academic performance, particularly in relation to their use of ICT for academic purposes. Best practices in the use in teaching and learning include the integration of ICT into the curriculum, the use of multimedia resources, and the provision of training and support for teachers. Challenges in the use of ICT in teaching and learning include limited access to ICT resources, inadequate infrastructure and technology support, and a lack of training and professional development for teachers.

This chapter provides a comprehensive overview of the findings and interpretations based on the data collected; setting the stage for the concluding chapter that will summarize the research and offer actionable recommendations.

## CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

### 5.0 Introduction

This chapter summarizes the findings of the study, draws conclusions in relation to the research objectives, and provides recommendations for improving the use of ICT in teaching and learning at Batanai High School.

#### 5.1 Summary of the study

This study is about how ICT enabled instruction for the teaching of quadratic equations. **Chapter 1** introduces the research study on uses of ICT in solving quadratic equations. The background of the study highlights the importance of quadratic equations in the mathematics curriculum and the challenges learners face in solving them. The purpose of the study is to identify and analyze how ICT enabled instruction for the teaching of quadratic equations by form 3 learners at a certain school in Mazowe District when solving quadratic equations. The research objectives include examining the current practices and approaches used by teachers in integrating ICT in teaching quadratic equations, identifying the benefits and challenges of using ICT in teaching quadratic equations, exploring the attitudes and perceptions of secondary mathematics students towards the use of ICT in teaching quadratic equations and provide recommendations for effective use of ICT in teaching quadratic equations. The study aims to provide valuable insights for teachers, policymakers, and researchers to develop targeted instructional approaches and interventions to improve learner understanding and performance in mathematics. The chapter also outlines the significance of the study, limitations, delimitations, definition of key terms, and the organization of the study.

**Chapter 2** provides a comprehensive review of the literature related to the research study on analyzing how ICT enabled instruction for the teaching of quadratic equations. The theoretical framework for the study is based on Bloom's Taxonomy of objectives, which provides a hierarchical classification of learning objectives in the cognitive domain. The literature review highlights the uses of ICT when solving quadratic equations, including procedural, technical/foundational, computational, and conceptual errors. The study also identifies the fundamental knowledge necessary for learners to effectively solve quadratic equations, including a solid foundation in basic algebraic concepts, factoring skills, number

sense, problem-solving strategies, and familiarity with mathematical notation and terminology. The literature review also discusses various studies that have analyzed student errors in solving quadratic equations, shedding light on the misconceptions and challenges that students face in mastering the concept using ICT. The studies highlight the importance of targeted interventions and instructional strategies to address learners' weaknesses in prerequisite skills and concepts, such as explicit instruction, guided practice, and frequent review. The chapter concludes by emphasizing the need for a comprehensive approach to address learner errors in involving ICT and improve student understanding and problem-solving skills in mathematics.

**Chapter 3** outlines the research methodology that will be used in this study. The research design is a qualitative case study, and the research paradigm that will guide this study is interpretivism. The population for this study is the teachers and students at Batanai High School in Mazowe, Zimbabwe. Data will be collected through semi-structured interviews and focus group discussions, and analysed using thematic analysis and content analysis. The researcher will ensure the trustworthiness of the data by using triangulation, member checking, and peer debriefing. Ethical approval will be sought from the University of Zimbabwe's Department of Research and Ethics before the study begins, and informed consent will be obtained from all participants.

This chapter has outlined the research methodology adopted for this study, detailing the design, population, sampling techniques, data collection methods, and analysis strategies. By employing a mixed-methods approach, the study seeks to provide a comprehensive understanding of the integration of ICT in teaching quadratic equations in Zimbabwean secondary schools. The subsequent chapters will present the findings and discussions based on the data collected.

The chapter focused on the research design used in the study and why that design was chosen over others. It also focused on the target population, sample size and the sampling techniques which were used, the structure of the research instruments and why the instruments were to be chosen. Attention was also centred on data collection procedures outlined as well as how the data could be presented and analysed to make meaningful information. All this will be achieved when the data is presented.

**Chapter 4** presents the data collected for this study, analyses and interprets the findings in relation to the research objectives, and draws conclusions based on the analysis. The findings

indicate that the use of ICT in teaching and learning at Batanai High School is influenced by several factors, including teachers' attitudes, students' attitudes, availability and accessibility of ICT resources, infrastructure and technology support, training and professional development for teachers, and school policies and support for the use of ICT. The study also found that the use of ICT has a positive impact on students' academic performance, particularly in relation to their use of ICT for academic purposes. Best practices in the use in teaching and learning include the integration of ICT into the curriculum, the use of multimedia resources, and the provision of training and support for teachers. Challenges in the use of ICT in teaching and learning include limited access to ICT resources, inadequate infrastructure and technology support, and a lack of training and professional development for teachers.

This chapter provides a comprehensive overview of the findings and interpretations based on the data collected; setting the stage for the concluding chapter that will summarize the research and offer actionable recommendations.

**Chapter five** gives summary, conclusions and recommendations of the study. A summary is for summarizing the main points of each chapter, the conclusions are for giving final comments or judgments on the findings of the research and finally the recommendations which are suggestions or strategies that may be put in place in order to deal with analysis of students' errors when solving quadratic equations using factorization.

#### **5.1.1 Enhanced Understanding through ICT**

The findings indicate that the integration of ICT tools significantly enhances students' understanding of quadratic equations. Students reported that visual aids and interactive software made complex concepts more approachable. This aligns with the constructivist learning theory, which emphasizes that learners construct knowledge through interactive experiences. The positive feedback from students regarding the use of ICT supports findings from previous research (An & Tindal, 2006; Hattie, 2009), which also highlighted the effectiveness of technology in improving comprehension in mathematics.

#### **5.1.2 Increased Motivation and Engagement**

The study found that the use of ICT in lessons led to increased motivation and engagement among students. The majority of students felt more involved in lessons when ICT tools were utilized, corroborating the findings of Mwale and Muliya (2020) that technology fosters a more dynamic and interactive learning environment. The observation of high student

participation during ICT-enabled lessons underlines the importance of engaging teaching methods in promoting active learning.

### 5.1.3 Challenges in ICT Integration

Despite the benefits, the study identified several challenges that hinder the effective integration of ICT in teaching. Limited access to resources, such as computers and internet connectivity, poses significant barriers. This finding is consistent with Chikoko et al. (2015), who highlighted infrastructural limitations in Zimbabwean schools. Additionally, resistance from some students towards the use of technology suggests a need for change management strategies to facilitate a smoother transition to ICT-enhanced teaching methods.

## 5.2 Implications of the Study

The implications of this study are multifaceted:

1. Educational Policy: The findings underscore the need for educational policymakers to prioritize ICT infrastructure development in schools. Investments in technology can enhance learning experiences and outcomes in mathematics education.
2. Teacher Training: Continuous professional development programs for teachers should focus on effective ICT integration strategies. Training sessions can help educators become more proficient in using technology to teach complex concepts.
3. Curriculum Development: The curriculum should be revised to incorporate ICT-based learning activities that align with modern educational practices, ensuring that students are equipped with relevant skills for the future.

## 5.3 Recommendations

Based on the findings of the study, the following recommendations are provided to improve the use of ICT in teaching and learning at Batanai High School:

There should be made a provision of training and professional development for teachers to enhance their skills and confidence in using ICT in teaching and learning. This could be through increasing access to ICT resources, including computers, internet, and other multimedia resources. There is need for improving infrastructure and technology support, including the provision of reliable and fast internet connectivity. There should be integration of ICT into the curriculum and provide opportunities for students to use ICT for academic purposes. There is need to develop and implement school policies which support the use of

ICT in teaching and learning. There is need for encouraging collaboration and sharing of best practices among teachers in the use of ICT in teaching and learning

Educators should adopt student-centered teaching methodologies that leverage ICT tools to promote active learning, encouraging students to explore mathematical concepts collaboratively. Future research should explore the long-term impact of ICT integration on student achievement in mathematics across different educational contexts in Zimbabwe.

#### 5.4 Conclusions (being answers to research questions/objectives)

The study found that the use of ICT in teaching and learning at Batanai High School is influenced by several factors, including teachers' attitudes, students' attitudes, availability and accessibility of ICT resources, infrastructure and technology support, training and professional development for teachers, and school policies and support for the use of ICT. The study also found that the use of ICT has a positive impact on students' academic performance, particularly in relation to their use of ICT for academic purposes. Best practices in the use of ICT in teaching and learning include the integration of ICT into the curriculum, the use of multimedia resources, and the provision of training and support for teachers. Challenges in the use of ICT in teaching and learning include limited access to ICT resources, inadequate infrastructure and technology support, and a lack of training and professional development for teachers.

Integration of ICT with other teaching methods requires technical support, training and professional development for teachers, and school policies and support for the use of ICT. The study also found that the use of ICT has a positive impact on students' academic performance, particularly in relation to their use of ICT for academic purposes. Best practices in the use of ICT in teaching and learning include the integration of ICT into the curriculum, the use of multimedia resources, and the provision of training and support for teachers. Challenges in the use of ICT in teaching and learning include limited access to ICT resources, inadequate infrastructure and technology support, and a lack of training and professional development for teachers.

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APPENDIX I:

LETTER OF AUTHORISATION TO CONDUCT RESEARAPPENDIX II:

## APPENIX II ANTI PLAGARISM REPORT

### **APPENDIX III:**

#### **INFORMED CONSENT TO PARTICIPATE IN RESEARCH-TEACHERS**

#### **INFORMED CONSENT TO PARTICIPATE IN RESEARCH FOR TEACHERS**

##### **Introduction :**

My name is Ruwoko Ashton and I am kindly asking for your assistance in the completion of my questionnaire. I am a Bindura University of Science Education (BUSE) student. As part of the requirements of the institution for the completion of the Bachelor of Science Education Honours Degree in Mathematics, I am carrying out a research entitled 'Examining the use of ICT in teaching Quadratic Equations to ordinary level Mathematics students at Batanai High School in Mazowe district'. It is against this background that I kindly seek your opinions by completing the attached questionnaires. This is a purely academic study and the results will be used for academic purposes only. Please feel free to say out your honest opinion and I assure you that all the information you provide will be treated in strict confidence. For any clarifications, please contact me on the details provided below.

Yours sincerely

Ruwoko Ashton

BUSE STUDENT (**B226639B**) cell number +263782 209 754 /0775 790 309

**ashtonruwoko@gmail.com**

#### APPENDIX IV:

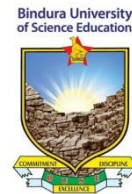
##### INFORMED CONSENT TO PARTICIPATE IN RESEARCH- LEARNERS

My name is Ruwoko Ashton. I am a Bindura University of Science Education (BUSE) student, Reg Number **B226639B**. I am from the Department of mathematics and science education. Your participation in this study is voluntary. Please read the information below and ask questions about anything you do not understand, before deciding whether to participate. I am carrying out a research entitled 'Examining the use of ICT in teaching Quadratic equations at Batanai High School in Mazowe district to ordinary level learners. It is against this background that I kindly seek your opinions by completing the attached questionnaires. There are no risks in taking part in this study. If you feel like not taking part in this study, no one will be upset with you or even if you accept and decide to change your mind later and want to stop you still do so. You can ask any questions that you have about the study. If you have, a question later that you did not think of now, you can call me on +263782 209 754 /0775 790 309. Signing your name at the bottom means that you agree to be in this study.

\_\_\_\_\_Date: \_\_\_\_\_

## APPENDIX V:

### QUESTIONNAIRES TO TEACHERS



BINDURA UNIVERSITY OF SCIENCE EDUCATION

EXAMINE THE USE OF ICT IN TEACHING QUADRATIC EQUATIONS TO  
SECONDARY SCHOOL MATHEMATICS STUDENTS: A CASE STUDY OF BATANAI  
HIGH SCHOOL

#### **TEACHERS QUESTIONNAIRE**

##### Instructions

- i) Please respond to all questions
- ii) Respond by ticking the applicable in questions where responses are provided and briefly explain where spaces are provided
- iii) There are no right or wrong answers, hence, please give the response that is closest to your opinion
- iv) Please note that all your responses will be treated with strict confidence and the study will be used for academic purposes only.

#### **Section A: Study Participants Demographics**

1. Age group (Please tick your age group)
  - a) 30 years and below [      ]
  - b) 31 – 35 years [      ]
  - c) 36 – 40 years [      ]
  - d) 41 – 45 years [      ]
  - e) Above 45 years [      ]

2. Number of years of teaching experience

- a) Less than 2 years [      ]
- b) 2 – 5 years [      ]
- c) 6 – 10 years [      ]
- d) 11 – 15 years [      ]
- e) More than 15 years [      ]

3. Highest Academic Qualifications

- a) CSC or 'O' Level [      ]
- b) HSC or A' Level [      ]
- c) B.A/B.Sc. [      ]
- d) Other (State which) .....

**Section B: ICT Experience and Perception**

1. How often do you use ICT devices (e.g., computers, tablets, smartphones) for teaching?

- Daily
- Weekly
- Monthly
- Rarely

2. How confident are you in using ICT devices for teaching?

- Very confident
- Somewhat confident

- Not very confident

- Not at all confident

3. What do you think are the benefits of using ICT in teaching quadratic equations? (Select all that apply)

- Improved student understanding

- Increased student engagement

- Better student retention

- Easier access to resources

- Other (please specify)

### **Section C: Quadratic Equations and ICT**

1. Have you ever used ICT to teach quadratic equations?

- Yes

- No

2. If yes, what ICT tools or resources have you used? (Select all that apply)

- Online tutorials

- Educational software

- Mobile apps

- Online games

- Other (please specify)

3. How helpful do you think ICT is in teaching quadratic equations?

- Very helpful

- Somewhat helpful

- Not very helpful

- Not at all helpful

#### **Section D: Challenges and Limitations**

1. What challenges have you faced in using ICT to teach quadratic equations? (Select all that apply)

- Technical issues
- Limited access to ICT devices
- Lack of training or support
- Other (please specify)

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2. How do you think these challenges can be addressed?

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Questionnaire:

**Purpose:** To gather teachers' perceptions and experiences with ICT tools in teaching quadratic equations.

Questions:

How frequently do you integrate ICT tools into your lessons on quadratic equations?

.....

.....

What ICT tools do you use most often, and why?

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How do you perceive the effectiveness of ICT tools in enhancing students' understanding of quadratic equations?

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What challenges do you encounter when using ICT tools in your teaching?

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**Interviews:**

Purpose: To gain detailed insights into teachers' experiences and strategies.

Interview Questions:

Can you describe your experience with using ICT tools in teaching quadratic equations?

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What benefits have you observed in students' learning when using ICT tools?

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What are the main challenges you face, and how do you address them?

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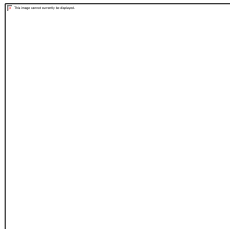
**Teacher's signature**

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## APPENDIX VI:

### QUESTIONNAIRES TO LEARNERS

#### INFORMED CONSENT TO PARTICIPATE IN RESEARCH- LEARNERS



#### **BINDURA UNIVERSITY OF SCIENCE EDUCATION**

EXAMINE THE USE OF ICT IN TEACHING QUADRATIC EQUATIONS TO  
SECONDARY SCHOOL MATHEMATICS STUDENTS: A CASE STUDY OF BATANAI  
HIGH SCHOOL

##### **Instructions**

- i) Please respond to all questions
- ii) Respond by ticking the applicable in questions where responses are provided and briefly explain where spaces are provided
- iii) There are no right or wrong answers, hence, please give the response that is closest to your opinion
- iv) Please note that all your responses will be treated with strict confidence and the study will be used for academic purposes only

#### **Student Questionnaire on ICT Use in Learning Quadratic Equations**

1. Age: \_\_\_\_\_
2. Form level: \_\_\_\_\_
3. Sex: Male/Female [   ]

#### **Section B: ICT Experience and Perception**

1. How often do you use ICT devices (e.g., computers, tablets, smartphones) for learning?

- Daily [ ☐ ]
- Weekly [ ☐ ]
- Monthly [ ☐ ]
- Rarely [ ☐ ]

2. How confident are you in using ICT devices for learning?

- Very confident
- Somewhat confident
- Not very confident
- Not at all confident

3. What do you think are the benefits of using ICT in learning quadratic equations? (Select all that apply)

- Improved understanding
- Increased engagement
- Better retention
- Easier access to resources
- Other (please specify)

### **Section C: Quadratic Equations and ICT**

1. Have you ever used ICT to learn quadratic equations?

- Yes [ ☐ ]
- No [ ☐ ]

2. If yes, what ICT tools or resources have you used? (Select all that apply)

- Online tutorials [ ☐ ]
- Educational software[ ☐ ]
- Mobile apps[ ☐ ]
- Online games[ ☐ ]
- Other (please specify) [ ☐ ]

3. How helpful do you think ICT is in learning quadratic equations?

- Very helpful [ ☐ ]
- [ ☐ ] Somewhat helpful
- [ ☐ ] Not very helpful
- [ ☐ ] Not at all helpful

1. How often do you use ICT tools (e.g., GeoGebra, Desmos) in your math classes?

- [ ☐ ] Never
- [ ☐ ] Rarely
- [ ☐ ] Sometimes
- [ ☐ ] Often
- [ ☐ ] Always

2. How do you feel about using ICT tools to learn quadratic equations?

- [ ☐ ] Very Negative
- [ ☐ ] Negative
- [ ☐ ] Neutral
- [ ☐ ] Positive

- [ ] Very Positive

3. Do you find ICT tools helpful in understanding quadratic equations? Why or why not?

- [ ] Yes

- [ ] No

- Please explain:

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4. Rate your confidence in solving quadratic equations before and after using ICT tools.

- Before: [ ] Very Low [ ] Low [ ] Neutral [ ] High [ ] Very High

- After: [ ] Very Low [ ] Low [ ] Neutral [ ] High [ ] Very High

### **For Students**

#### **Questionnaire:**

Purpose: To gather students' perceptions and experiences with ICT tools in learning quadratic equations.

Questions:

How often do you use ICT tools (e.g., GeoGebra, Desmos) in your math classes?

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How do you feel about using ICT tools to learn quadratic equations?

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Do you find ICT tools helpful in understanding quadratic equations? Why or why not?

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Rate your confidence in solving quadratic equations before and after using ICT tools.

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Focus Group Discussions:

Purpose: To obtain in-depth insights into students' attitudes and experiences.

Discussion Points:

Describe your experience using ICT tools in learning quadratic equations.

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What challenges do you face when using these tools?

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How do ICT tools compare to traditional teaching methods in terms of understanding quadratic equations?

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**Signature** ..... **Date** .....