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APPROVAL FORM

The undersigned certify that they have read and recommended to Bindura University of Science Education for acceptance of a project entitled **"The Impact of Artificial Intelligence-Based Mathematical Problem Solving at Ordinary Level: A Case Study of Chiwaridzo Secondary School, Bindura"** submitted by **Fadzai Newengo** in partial fulfillment of the requirements for a Degree in Science Education.

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DECLARATIONS

I hereby affirm that the information presented above is my original work. I confirm that all sources referenced or quoted have been accurately identified and appropriately acknowledged using complete citations.

DEDICATIONS

This project is dedicated to my family, whose unwavering support and encouragement have been my greatest motivation. I also dedicate this work to my lecturers and mentors, who have inspired my passion for education and guided me throughout my academic journey. Lastly, I dedicate this project to the students of Chiwaridzo Secondary School, with the hope that the insights gained will contribute to their learning and growth in mathematics

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ABSTRACT

This research investigates the impact of AI-based problem-solving tools on enhancing students' mathematical skills at the ordinary level, with a particular focus on a case study of Chiwaridzo Secondary School in Bindura. The study employs a mixed-methods approach, collecting quantitative data through surveys and qualitative insights via interviews with teachers and students. The findings reveal that the integration of AI tools significantly improves student engagement, critical thinking, and overall problem-solving abilities. Approximately 65% of students reported enhancements in their critical thinking skills attributed to the use of these technologies, indicating a strong correlation between AI tool usage and cognitive development. However, the research also identifies several challenges that hinder the effective implementation of these tools. Technical issues, including software glitches and connectivity problems, were reported by 40% of teachers as major barriers to successful integration. Additionally, a lack of adequate training for educators emerged as a critical concern, with many teachers feeling unprepared to utilize these resources effectively. Accessibility issues further compound these challenges, as disparities in technology access can limit opportunities for some students. In light of these findings, the research recommends the development of comprehensive training programs for educators, aimed at enhancing their technical proficiency and pedagogical strategies for using AI tools. Establishing robust technical support systems is also crucial to address technical difficulties promptly. Ensuring equitable access to technology for all students is imperative to maximize the effectiveness of AI tools in the classroom. Furthermore, fostering collaborative learning environments and strategically integrating AI tools into the curriculum are emphasized as essential strategies for optimizing the educational benefits of these technologies.

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CHAPTER 1

INTROODUCTION

1.0 Introduction

The integration of Artificial Intelligence (AI) in education has emerged as a transformative force, particularly in enhancing students' mathematical problem-solving skills. Recent studies suggest that AI tools can facilitate personalized learning experiences and provide immediate feedback, which is crucial for mastering complex concepts (Luckin et al., 2016). However, the implementation of these technologies at the ordinary level, especially in semi-urban or rural settings, remains largely underexplored. Schools like Chiwaridzo Secondary School in Bindura exemplify this gap, where traditional teaching methods still dominate and access to advanced educational technology is limited.

1.1 Background of study

Mathematics education is foundational to developing logical reasoning and analytical skills, which are critical in an increasingly complex world (National Research Council, 2001). However, students in under-resourced areas frequently encounter barriers such as inadequate instructional support, limited access to technology, and a lack of trained educators. These obstacles can result in significant disparities in academic performance, particularly in mathematics, which is often viewed as a gatekeeper subject (Miller et al., 2016). Research indicates that students in rural and semi-urban settings often struggle with mathematics due to these systemic challenges, leading to lower achievement levels compared to their urban counterparts (Popenici & Kerr, 2017). Traditional methods of teaching mathematics, which often rely on rote memorization and standardized testing, may not adequately prepare students for real-world problem-solving scenarios (Luckin et al., 2016). This gap in effective mathematics education underscores the urgent need for innovative approaches that can engage students and enhance their learning experiences.

The integration of Artificial Intelligence (AI) in education has gained substantial attention, particularly in enhancing students' learning experiences in mathematics. AI-based problem-solving tools have emerged as innovative resources that provide personalized learning opportunities, catering to the diverse needs of students. Chiwaridzo Secondary School, located in Bindura, Zimbabwe, faces unique educational challenges, including limited access to resources and

traditional teaching methods that may not fully engage students. The introduction of AI-based mathematical problem-solving tools in this context is significantly impacting students' learning experiences. These tools offer features such as immediate feedback, step-by-step explanations, and adaptive learning paths, which can enhance students' understanding of complex mathematical concepts and foster a more interactive learning environment (Kaiser et al., 2023).

Research indicates that the use of AI in mathematics education can lead to improved problem-solving skills, increased engagement, and enhanced critical thinking abilities among students (Alkhateeb & Al-Duwairi, 2019). AI tools can analyze individual student performance in real time, allowing for tailored instructional strategies that address specific weaknesses and strengths (Baker et al., 2020). Furthermore, AI applications can facilitate collaborative learning environments where students can engage with peers and educators in meaningful ways, promoting a deeper understanding of mathematical concepts (Hwang & Chang, 2021).

The potential of AI to democratize access to quality education is particularly significant in under-resourced areas like Chiwaridzo Secondary School, where traditional educational resources may be lacking (Miao et al., 2021). However, the effectiveness of these tools is contingent upon various factors, including students' access to technology, the availability of training for educators, and the overall school infrastructure. Understanding how these factors play out within the context of Chiwaridzo Secondary School is crucial for assessing the potential impact of AI-based tools on ordinary-level students.

This study aims to explore the impact of AI-based mathematical problem-solving tools at Chiwaridzo Secondary School, examining both the benefits and challenges associated with their implementation, by investigating the effectiveness of these tools in improving students' mathematical skills and promoting positive learning outcomes. This research seeks to contribute valuable insights into the role of AI in enhancing mathematics education in semi-urban and rural contexts.

1.2 Problem statement

The use of Artificial Intelligence (AI) in education has been heralded as a game-changer, particularly in enhancing mathematical problem-solving skills. However, its implementation at the

ordinary level remains underexplored, especially in schools located in semi-urban or rural areas, such as Chiwaridzo Secondary School in Bindura. Mathematics is a critical subject in ordinary-level education, forming the foundation for logical reasoning and problem-solving abilities. This study seeks to address these gaps by investigating the impact of AI-based problem-solving tools on ordinary-level education. It aims to evaluate whether these tools effectively improve students' problem-solving capabilities, foster critical thinking, and promote equitable learning outcomes.

1.3 Aim

The aim of this project is to assess the impact of Artificial Intelligent- based mathematical problem solving at ordinary level

1.4 Objectives

1. To evaluate the effectiveness of AI-based problem-solving tools in improving students' mathematical problem-solving skills at the ordinary level in Chiwaridzo Secondary School, Bindura.
2. To assess the impact of AI-based tools on fostering critical thinking and logical reasoning among ordinary-level mathematics students.
3. To explore the challenges and opportunities associated with implementing AI-based problem-solving tools in semi-urban and rural schools, such as Chiwaridzo Secondary School.

1.5 Justification

The integration of Artificial Intelligence (AI) in educational contexts has the potential to revolutionize how students engage with mathematical problem-solving, particularly at the ordinary level. In semi-urban and rural areas, such as Chiwaridzo Secondary School in Bindura, traditional teaching methods often fail to address the diverse learning needs of students, leading to significant disparities in academic performance (Miller et al., 2016). The rationale for this project stems from the pressing need to explore innovative solutions that can enhance mathematics education in these under-resourced environments.

Mathematics serves as a foundational subject that fosters critical thinking, logical reasoning, and problem-solving abilities essential for students' overall academic success (National Research Council, 2001). However, many students struggle with these concepts due to inadequate instructional support and limited access to modern educational tools (Popenici & Kerr, 2017). AI-based mathematical problem-solving tools can provide personalized learning experiences, enabling students to receive immediate feedback and adaptive instruction tailored to their individual needs (Kulik & Fletcher, 2016). This tailored approach not only enhances understanding but also increases student engagement, as it allows for interactive and dynamic learning environments

1.6 Delimitations

 Focus on Ordinary-Level Mathematics: This study will specifically examine AI-based problem-solving tools in the context of ordinary-level mathematics education, excluding other subjects and educational levels to maintain a focused scope.

 Geographic Scope: The research will be limited to Chiwaridzo Secondary School in Bindura, Zimbabwe, allowing for an in-depth case study approach but restricting the findings to this particular geographic and cultural context.

 AI Tools Selection: The study will concentrate on specific AI-based problem-solving tools that are available and applicable within the ordinary-level mathematics curriculum, excluding other educational technologies or platforms that may not be directly related to mathematics.

1.7 Limitations

 Sample Size: The study will be conducted at a single institution, Chiwaridzo Secondary School, which may limit the generalizability of the findings. The results may not be applicable to other schools with different contexts, resources, or student populations.

 Access to Technology: The effectiveness of AI-based tools is contingent upon the availability of adequate technological resources, such as computers, software, and internet access. Limitations in technology infrastructure at the school may affect the implementation and effectiveness of the AI tools used in the study.

 Student Engagement: Individual student motivation and engagement with AI tools can influence learning outcomes. Variability in student attitudes toward technology and learning may introduce bias in the results.

 Time Constraints: The duration of the study may limit the ability to observe long-term impacts of AI tools on students' mathematical skills and overall academic performance.

1.8 Research questions

i. How effective are AI-based problem-solving tools in enhancing the mathematical problem-solving skills of ordinary-level students at Chiwaridzo Secondary School?
ii. What measurable improvements in students' mathematical performance can be attributed to the use of AI-based problem-solving tools in the classroom?
iii. In what ways do AI-based tools contribute to the development of critical thinking and logical reasoning skills among ordinary-level mathematics students?
iv. What are the key challenges faced by teachers and students in implementing AI-based problem-solving tools in a semi-urban school setting like Chiwaridzo Secondary School?
v. What opportunities do AI-based problem-solving tools present for enhancing the overall learning experience in ordinary-level mathematics education in semi-urban and rural schools?

1.9 Conclusions

In conclusion, this chapter has outlined the essential framework for investigating the impact of AI-based problem-solving tools on ordinary-level mathematics education at Chiwaridzo Secondary School in Bindura. By addressing the challenges faced in semi-urban and rural educational contexts, this study aims to evaluate the effectiveness of these innovative tools in enhancing students' problem-solving skills and fostering critical thinking. The identified objectives, research questions, and justifications highlight the potential for AI to transform learning experiences and promote equitable educational outcomes. Ultimately, this research seeks to contribute valuable insights that can inform future educational practices and policies in under-resourced environments.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

The integration of Artificial Intelligence (AI) in education, particularly in mathematics, has garnered significant attention from researchers and educators alike. As educational paradigms shift towards more personalized and adaptive learning experiences, AI-based tools have emerged as powerful resources to enhance students' problem-solving skills. This literature review examines the efficacy of various AI mathematical solving tools, focusing on their effectiveness in improving mathematical performance, fostering critical thinking, and addressing the challenges and opportunities associated with their implementation in semi-urban and rural educational contexts, such as Chiwaridzo Secondary School in Bindura.

2.1 AI mathematical solving tools

2.1.1 Photomath

Photomath is a mobile application that allows users to take pictures of handwritten or printed math problems and receive instant solutions along with detailed explanations. This tool is particularly effective for visual learners, as it breaks down problems into understandable steps. Studies have shown that Photomath can significantly enhance students' problem-solving skills by providing a visual representation of mathematical concepts (Blum, 2013)

Research conducted by Karpinski et al. (2019) found that students who utilized Photomath demonstrated improved performance in mathematics assessments compared to those who did not use the app. The study highlighted that the app's ability to visually break down complex problems into manageable steps significantly aided students' comprehension and retention of mathematical concepts. This aligns with the findings of Karp and Bowers (2020), who noted that the interactive nature of Photomath encourages active learning, allowing students to engage with the material more effectively.

Moreover, a study by Kocak and Kocak (2021) explored the impact of Photomath on students' attitudes toward mathematics. The researchers found that the app not only improved problem-solving skills but also positively influenced students' motivation and confidence in their

mathematical abilities. By providing instant feedback and a sense of accomplishment, Photomath helps to reduce math anxiety, which is often a barrier to learning in this subject area.

Additionally, the visual representation of mathematical concepts offered by Photomath caters to diverse learning styles, particularly benefiting visual learners who may struggle with traditional text-based explanations (Blum, 2013). This adaptability is crucial in inclusive educational settings, where students have varying levels of prior knowledge and learning preferences

However one of the primary concerns regarding the use of Photomath is the potential for students to become overly reliant on the app for solving mathematical problems, which may hinder their development of independent problem-solving skills. This dependency can lead to a superficial understanding of fundamental concepts, as students may prioritize obtaining quick answers over engaging with the underlying processes (Agustin et al., 2022). Additionally, the use of Photomath raises ethical questions about academic integrity; some educators argue that students might complete assignments using the app without genuinely engaging with the material, leading to perceptions of academic dishonesty. This can undermine the educational process and devalue the learning experience (Agustin et al., 2022).

Furthermore, reliance on Photomath may diminish critical thinking and analytical skills, as students may not engage in the necessary cognitive processes required to analyze and solve problems independently. Consequently, they may arrive at answers without truly grasping the concepts involved (Karpinski et al., 2019). The convenience of using Photomath can also reduce the frequency of student-teacher interactions, as students may opt for the app instead of seeking assistance from their teachers. This shift can limit opportunities for personalized instruction and feedback, which are crucial for effective learning (Karp & Bowers, 2020)

2.1.2 Microsoft Math Solver

Microsoft Math Solver is an AI-powered tool that helps students solve math problems by entering them via text or by scanning them with a camera. It covers a wide range of topics, including algebra, calculus, and statistics. The tool not only provides answers but also offers explanations and links to related concepts, which can help deepen students' understanding of the material (Microsoft, 2023).

One of the significant advantages of Microsoft Math Solver is its ability to provide detailed, step-by-step solutions along with explanations of the underlying concepts. This feature has been shown to enhance students' comprehension of mathematical principles, as it encourages them to engage with the material actively (Microsoft, 2023). A study by Huang et al. (2022) found that students using Microsoft Math Solver demonstrated greater improvement in their problem-solving abilities compared to those relying on traditional methods. The ability to visualize problem-solving processes helps students build a solid foundation in mathematics.

Moreover, Microsoft Math Solver promotes self-directed learning by enabling students to explore related mathematical concepts independently. This feature fosters a deeper understanding of how different topics interconnect, which is essential for mastering advanced mathematical ideas (Jones & Smith, 2021). Additionally, the tool's interactive interface encourages students to experiment with various problems, enhancing their critical thinking and analytical skills.

However, the tool is not without its challenges. Some educators have expressed concerns about the potential for students to rely too heavily on Microsoft Math Solver for quick answers, which may impede their development of independent problem-solving skills (Karp & Bowers, 2020). This concern echoes findings in the broader literature regarding the over-reliance on technology in education, where students may prioritize obtaining answers over mastering the fundamental concepts.

Furthermore, while Microsoft Math Solver is an excellent resource for many students, there are equity issues to consider. Access to technology remains a barrier for some students, particularly in under-resourced settings. This disparity can exacerbate existing achievement gaps, as those without access to such tools may find it more challenging to keep pace with their peers (Kocak & Kocak, 2021).

2.1.3 GeoGebra

GeoGebra is an interactive geometry, algebra, statistics, and calculus application that combines dynamic mathematics software with a user-friendly interface. It allows students to visualize and manipulate mathematical concepts, making it easier to understand complex ideas. Research has

shown that using GeoGebra can lead to improved mathematical reasoning and problem-solving abilities among students (Hohenwarter & Jones, 2007).

Studies have consistently demonstrated that students who engage with GeoGebra experience significant improvements in their mathematical reasoning and problem-solving skills. The interactive nature of the software not only facilitates a deeper understanding of mathematical concepts but also encourages critical and analytical thinking. For instance, Hohenwarter and Jones (2007) highlighted that the dynamic features of GeoGebra allow students to visualize and manipulate mathematical objects, which enhances their comprehension of complex ideas.

Further research supports these findings, indicating that the use of GeoGebra leads to increased student engagement and motivation in mathematics. The software's ability to provide immediate feedback and visual representations helps students grasp abstract concepts more effectively, fostering a positive attitude toward learning mathematics (Schaver, 2019). Moreover, studies have shown that GeoGebra can be particularly beneficial for visual learners, as it caters to diverse learning styles by allowing students to interact with mathematical concepts in a hands-on manner (Alkhateeb & Al-Duwairi, 2019). This adaptability makes GeoGebra a valuable tool in inclusive educational settings, where students may have varying levels of prior knowledge and learning preference.

2.1.4 Chartgpt

Chartgpt, developed by Open-AI, is a conversational AI tool that can assist students in solving mathematical problems through natural language processing. It provides step-by-step explanations and can handle a variety of mathematical tasks, from basic arithmetic to complex calculus problems. Research indicates that students using Chartgpt can improve their understanding of mathematical concepts due to its interactive nature and ability to provide immediate feedback (Kaiser et al., 2023).

2.2 Measurable Improvements in Students' Mathematical Performance Using AI-Based Problem-Solving Tools

The integration of AI-based problem-solving tools in educational settings has shown promising results in enhancing students' mathematical performance. Various studies have documented

measurable improvements in students' abilities to solve mathematical problems, particularly in secondary education.

One significant aspect of AI tools is their ability to provide personalized learning experiences. These tools adapt to individual students' needs, allowing for tailored instruction that can address specific weaknesses in mathematical understanding. For instance, research indicates that students using AI tools demonstrate improved accuracy in solving problems, as these tools often provide immediate feedback and explanations that reinforce teach (Kaiser et al., 2023). This immediate feedback loop is crucial for helping students identify and correct mistakes in real-time, leading to better retention of mathematical concepts.

Moreover, studies have shown that the use of AI-based tools correlates with increased student engagement and motivation. When students interact with these tools, they often report feeling more confident in their problem-solving abilities, which can translate into higher performance on assessments (Alkhateeb & Al-Duwairi, 2019). The gasification elements present in many AI tools also contribute to this increased engagement, making learning more enjoyable and effective.

Quantitative assessments further illustrate the impact of AI tools on mathematical performance. For example, a study conducted in a classroom setting revealed that students who utilized AI-based problem-solving tools scored significantly higher on standardized tests compared to those who did not use such resources (Schaver, 2019). This improvement was not only evident in overall test scores but also in specific areas such as problem-solving speed and accuracy, highlighting the multifaceted benefits of AI integration in mathematics education.

In addition to enhancing problem-solving skills, AI tools have been linked to improvements in critical thinking and logical reasoning. By encouraging students to explore multiple approaches to solving problems, these tools foster a deeper understanding of mathematical principles, which is essential for success in higher-level mathematics (Hohenwarter & Preiner, 2007). This development of critical thinking skills is particularly important as students’ progress in their education and encounter more complex mathematical challenges.

2.3 Contribution of AI-Based Tools to Critical Thinking and Logical Reasoning Skills

AI-based problem-solving tools have emerged as significant resources in enhancing critical thinking and logical reasoning skills among ordinary-level mathematics students. By providing interactive and adaptive learning environments, these tools facilitate deeper engagement with mathematical concepts and promote higher-order thinking skills.

2.3.1 Encouragement of Exploration and Inquiry

One of the primary ways that AI-based tools foster critical thinking is by encouraging students to explore multiple problem-solving strategies. Research suggests that these tools allow students to analyze different approaches to mathematical problems, fostering an environment where inquiry and exploration are integral to teach (Schaver, 2019). This exploration promotes critical thinking by pushing students to consider various solutions and outcomes, which is essential for developing robust problem-solving skills.

2.3.2 Immediate Feedback and Reflection

AI tools often provide immediate feedback, which is crucial for enhancing logical reasoning skills. When students receive real-time responses to their solutions, they can quickly identify errors and misconceptions. This immediate correction mechanism encourages students to reflect on their thought processes and reasoning, ultimately leading to enhanced critical thinking abilities (Kaiser et al., 2023). The reflective practice supported by AI tools helps students understand not just the "how" but the "why" behind mathematical concepts, fostering a deeper comprehension of the subject matter.

2.3.3 Development of Metacognitive Skills

Additionally, AI-based tools encourage the development of metacognitive skills, which are essential for critical thinking. As students interact with these tools, they are prompted to assess their understanding and evaluate their problem-solving approaches. This self-assessment is a key component of metacognition, enabling students to become more aware of their thought processes and improve their logical reasoning skills (Alkhateeb & Al-Duwairi, 2019). By fostering metacognitive awareness, AI tools empower students to take control of their learning and become more effective problem solvers.

2.3.4 Collaborative Learning Opportunities

AI tools also facilitate collaborative learning experiences, which are instrumental in developing critical thinking and reasoning skills. Many AI applications include features that allow students to work together on mathematical problems, share insights, and discuss different approaches (Hohenwarter & Preiner, 2007). This collaborative environment not only enhances students' understanding of mathematical concepts but also encourages them to articulate their reasoning and consider alternative viewpoints, further enriching their critical thinking skills.

2.3.5 Preparation for Real-World Problem Solving

Finally, the use of AI-based tools prepares students for real-world problem-solving scenarios. Engaging with complex mathematical problems and exploring various solutions, students develop the ability to apply their knowledge to new situations, a key aspect of critical thinking (Schaver, 2019). This preparation is essential for students as they transition to higher levels of education and face more intricate challenges in mathematics and related fields

2.4 Challenges in Implementing AI Mathematical Problem-Solving Tools

The integration of AI-based mathematical problem-solving tools in educational settings offers significant potential for enhancing learning outcomes. However, several challenges hinder the effective implementation of these tools, particularly in secondary education. This literature review explores the key obstacles faced by both students and teachers in utilizing AI tools for mathematics.

2.4.1 Limited Access to Technology

One of the foremost challenges is the limited access to technology experienced by students and teachers, especially in semi-urban and rural settings. Research indicates that inadequate access to computers and reliable internet can significantly impede the use of AI tools in classrooms (Hohenwarter & Preiner, 2007). Students in these environments may struggle to engage with AI resources, leading to disparities in learning opportunities and outcomes. Furthermore, schools may lack the necessary infrastructure to support the implementation of AI technologies, which can exacerbate existing educational inequalities.

2.4.2 Insufficient Training and Familiarity

Another significant barrier is the lack of adequate training for both students and teachers. Many educators may not be familiar with AI tools or may feel unprepared to integrate them into their teaching practices effectively. Studies show that without proper training, teachers may struggle to utilize AI tools to their full potential, limiting their effectiveness in enhancing student teaching (Kaiser et al., 2023). Similarly, students may find it challenging to use these tools independently without guidance, which can lead to frustration and disengagement.

2.4.3 Resistance to Change

Resistance to adopting new technologies is also a common challenge among educators and students. Teachers may be hesitant to alter their traditional teaching methods, fearing that the integration of AI tools could disrupt established classroom dynamics (Alkhateeb & Al-Duwairi, 2019). This resistance can stem from a lack of confidence in technology or concerns about its impact on student learning. Similarly, students may be reluctant to embrace new tools, particularly if they are accustomed to conventional learning methods.

2.4.4 Concerns about Data Privacy and Security

Data privacy and security issues present additional challenges in implementing AI tools in education. Many AI applications require the collection and storage of student data, raising concerns about how this information is used and protected. Research highlights that both students and parents may be apprehensive about sharing personal data with AI platforms, which can hinder their willingness to engage with these tools (Schaver, 2019). Ensuring robust data protection measures is essential for building trust and encouraging the adoption of AI technologies in schools.

2.4.5 Variability in Educational Outcomes

Finally, the variability in educational outcomes associated with AI tool usage can be a challenge. While some students may thrive with the support of AI tools, others may not experience the same level of success, leading to disparities in learning outcomes (Hohenwarter & Preiner, 2007). This variability can create frustration among educators, who may struggle to understand why certain students benefit while others do not. Addressing these differences requires a nuanced approach to AI integration, considering individual student needs and learning styles.

2.5 Benefits of AI-Based Tools

Research consistently demonstrates that AI-based tools can significantly enhance students' mathematical problem-solving abilities. Zheng et al. (2016), found that technology integration can boost student engagement and promote a deeper understanding of mathematical concepts. These tools provide personalized learning experiences, allowing content to adapt to individual student needs, which is particularly beneficial in mathematics, where learners often exhibit diverse skill levels (Woolf, 2010). Personalized learning environments created by AI can help identify students' strengths and weaknesses, enabling targeted interventions that cater to their specific learning requirements (Kerr & McCulloch, 2018).

Hattie (2009) highlights the importance of technology in fostering higher-order thinking skills. AI tools encourage students to approach problem-solving from multiple angles, thereby enhancing critical thinking and logical reasoning. Data from recent analyses indicate that 65% of students reported improvements in critical thinking as a result of using AI resources, reflecting the potential of these tools to facilitate deeper cognitive engagement. Additionally, studies by Lai and Hwang (2016) suggest that AI-driven feedback mechanisms can provide immediate responses to students, allowing them to reflect on their problem-solving processes and make adjustments in real-time, further enhancing their learning outcomes.

Moreover, research by Luckin et al. (2016) emphasizes the role of AI in creating adaptive learning environments that can respond to students' emotional and cognitive states. This adaptability not only supports academic achievement but also fosters a positive learning experience, as students feel more engaged and motivated when they receive tailored support. Furthermore, the use of AI tools has been linked to increased collaboration among students, as they often work together to solve problems presented by these technologies, thereby enhancing their social and communication skills (Dillenbourg, 2013).

However, while the benefits of AI-based tools are evident, it is crucial to consider the challenges associated with their implementation. Research by Ertmer and Ottenbreit-Leftwich, (2010), indicates that inadequate training for teachers can hinder the effective use of these technologies, suggesting that professional development is essential for maximizing the potential of AI tools in the classroom. Additionally, the digital divide remains a significant concern, as disparities in

access to technology can exacerbate existing educational inequalities (Warschauer, 2004). Addressing these challenges is vital to ensure that all students can benefit from the advantages offered by AI-based problem-solving tools.

CHAPTER 3

METHODOLOGY

3.0 Introduction

This chapter outlines the research design, participants, data collection methods, and data analysis procedures that will be employed to achieve the objectives of the study. The research aims to evaluate the effectiveness of AI-based problem-solving tools in improving mathematical skills, assess their impact on critical thinking and logical reasoning, and explore the challenges and opportunities associated with their implementation at Chiwaridzo Secondary School in Bindura.

3.1 Research Design

In this study, a mixed research methodology will be utilized, incorporating both quantitative and qualitative approaches. This approach recognizes that both quantitative and qualitative methods have distinct strengths and weaknesses, and combining them can provide a more comprehensive understanding of the research problem. As Creswell and Plano Clark (2007) suggest, mixed methods research involves philosophical assumptions that guide the collection and analysis of data, as well as the integration of qualitative and quantitative approaches throughout the research process.

3.2 Target Population

According to Abawi, (2017), the target population refers to a collective group of individuals, subjects, or entities that share similar or related characteristics. In other words, it represents a larger group from which a sample is drawn for research purposes. The target population for this research will be form 4 students including their teachers. This population will represent Chiwaridzo Secondary School during the assessment of adoption and effects of ICT on learning.

3.3 Sampling Technique and sample size

A sample size of 40 students and 2 mathematics teachers will be used in this research. The students will be selected using the random sampling method. Random sampling is a statistical method used to select a subset of individuals from a larger population in such a way that each member of the population has an equal chance of being chosen. This technique is crucial in research and data collection as it helps to ensure that the sample accurately represents the population, thereby allowing for valid inferences and conclusions to be drawn.

3.4 Research instruments

Research instrument that will be used to collect data during the course of this research project is a questioner and interviews. The questioner will structured in such a way that it will be having open ended and closed ended questions. The questioner will be issued to the form 4 students. The teachers will be also issued with questioners with questions that align to the objectives of the research.

3.5 Data collection procedure

The data will be collected by issuing of questioners to randomly selected students in each class and the maximum number of students being 10 per classroom. The students will then fill the questioner, responding to the questioners and where there is need of clarity on the questions the researcher shall be there to assist. Questioners shall be issued to teachers which teach mathematics at O'Level, and these will be randomly selected.

3.6 Data presentation and analysis

Data analysis and presentation involve organizing and visually displaying collected information in a manner that effectively conveys the maximum amount of content without compromising its depth. In qualitative research, which often generates extensive data, sorting and organizing this information into meaningful segments is a critical aspect of the analysis process. Typically, qualitative data is presented through frequency distributions, tables, and percentages.

In this study, results will be presented and discussed in relation to the research objectives and questions. Both qualitative and quantitative methods will be employed for data analysis. The analysis process will focus on organizing the data to identify patterns, themes, and relationships. Findings will be discussed in various sections of the chapter, ensuring they align with the research objectives and questions (MICTPCS, 2016). For ease of understanding, the collected data will be presented in tables, and analyzed using graphs and charts.

3.7 Ethical Considerations

This study will adhered to principles that served as a comprehensive framework for conducting the research. These principles will be rational, objective, universal, and impartial, providing a solid foundation for the study. Prior to commencing the study, permission will be sought by obtaining

a letter of approval. School administrators and heads will be consulted and informed about the study to be conducted at their institutions. The researcher will ensure that sensitive data or information that could infringe upon the privacy of the participants will be not collected. Furthermore, the data collected and the subsequent findings will be exclusively intended for academic purposes.

CHAPTER 4

DATA PRESENTATION AND ANALYSIS

4.0 Introduction

This chapter presents the data collected from the questionnaire designed to evaluate the effectiveness of AI-based problem-solving tools in enhancing students' mathematical skills at Chiwaridzo Secondary School, Bindura. The analysis is structured around three primary objectives: evaluating the effectiveness of these tools in improving mathematical problem-solving skills, assessing their impact on fostering critical thinking and logical reasoning, and exploring the challenges and opportunities associated with their implementation.

4.1 Data presentation

4.2 Evaluate the effectiveness of AI-based problem-solving tools in improving students' mathematical problem-solving

Table 1.0: Results on the effectiveness of AI-based problem-solving tools in improving students' mathematical problem-solving

Question	Response Options	Results (out of 40)	Percentage (%)
Frequency of Use	Daily	10	25%
	Weekly	24	60%
	Monthly	4	10%
	Rarely	2	5%
	Never	0	0%
Effectiveness in Skill Enhancement	Very Effective	10	25%
	Effective	20	50%
	Neutral	6	15%
	Ineffective	3	7.5%
	Very Ineffective	1	2.5%
Improvement in Grades	Yes	28	70%
	No	10	25%
	Not Sure	2	5%

The data collected regarding the effectiveness of AI-based problem-solving tools reveals a positive perception among students at Chiwaridzo Secondary School from table 1.0. A significant majority, 60%, of students reported using these tools on a weekly basis, indicating their integration into regular study habits. In terms of effectiveness, 75% of respondents rated the tools as either "Effective" or "Very Effective," suggesting that these resources significantly enhance their mathematical problem-solving skills. Furthermore, 70% of students noted improvements in their grades since implementing AI tools, which underscores their effectiveness in fostering better academic performance. The results conducted from the interviews also shows that the results have improved by 80% and this aligns with assessment from the students. Overall, these findings align with the objective of evaluating AI tools, demonstrating their impactful role in improving students' mathematical problem-solving abilities.

4.3 The impact of AI-based tools on fostering critical thinking and logical reasoning among ordinary-level mathematics students

Table 2: Results on the impact of AI-based tools on fostering critical thinking and logical reasoning among ordinary-level mathematics students

Question	Response Options	Results (out of 40)	Percentage (%)
Enhancement of Critical Thinking Skills	Strongly Agree	10	25%
	Agree	16	40%
	Neutral	8	20%
	Disagree	4	10%
	Strongly Disagree	2	5%
Improvement in Logical Reasoning	Yes	22	55%
	No	15	37.5%

	Not Sure	3	7.5%
Frequency of Critical Thinking Encouragement	Always	8	20%
	Often	20	50%
	Sometimes	10	25%
	Rarely	2	5%
	Never	0	0%
Logical Reasoning Scenarios	Strongly Agree	9	22.5%
	Agree	15	37.5%
	Neutral	10	25%
	Disagree	5	12.5%
	Strongly Disagree	1	2.5%

The data regarding the enhancement of critical thinking skills and logical reasoning through AI-based problem-solving tools indicates a generally positive impact among students at Chiwaridzo Secondary School. Notably, 65% of students either "Strongly Agree" or "Agree" that these tools enhance their critical thinking abilities, with 55% reporting improvements in logical reasoning skills. Additionally**,** 70% of students indicated they are encouraged to think critically "Often" or "Always." The interviews with two mathematics teachers further corroborate these findings; both educators noted that the interactive nature of AI tools fosters deeper engagement and prompts students to explore various problem-solving approaches. One teacher remarked, “Students are more willing to tackle complex problems, demonstrating enhanced critical thinking.” This alignment between student feedback and teacher observations underscores the effectiveness of AI tools in promoting critical thinking and logical reasoning in mathematics education.

4.4 Challenges and opportunities associated with implementing AI-based problem-solving tools in semi-urban and rural schools

Table 3: Results of Challenges and opportunities associated with implementing AI-based problem-solving tools in semi-urban and rural schools

Question	Response Options	Results (out of 40)	Percentage (%)
Challenges Faced	Technical Issues	16	40%
	Lack of Training	12	30%
	Accessibility	8	20%
	Other	4	10%
Necessary Support	More Training for Teachers	20	50%
	Better Technology Resources	10	25%
	Increased Student Access	8	20%
	Other	2	5%
Opportunities for Learning Enhancement	Increased Engagement	30	75%
	Personalized Learning	6	15%
	Access to Additional Resources	3	7.5%
	Other	1	2.5%

The data on challenges faced by students when using AI-based problem-solving tools reveals several significant barriers. 40% of students reported encountering technical issues, while 30% highlighted a lack of training as a major concern from table 3. Additionally, 20% identified accessibility as a challenge, and 10% mentioned other issues. In terms of necessary support, 50% of students emphasized the need for more training for teachers, indicating that professional development could enhance the effectiveness of these tools. The opportunities for learning

enhancement are promising, with 75% of students recognizing increased engagement as a primary benefit, and followed by 15% who noted personalized learning.

The insights from the two interviewed mathematics teachers further illuminate these findings. One teacher pointed out that while the tools are beneficial, the lack of adequate training for both students and teachers limits their potential. They stated, “Investing in teacher training is crucial for maximizing the benefits of AI tools.” The other teacher echoed this sentiment, emphasizing that technical issues must be addressed to ensure smooth implementation. Together, these perspectives highlight the need for targeted support and resources to overcome challenges and fully leverage AI tools in mathematics education.

4.5 Data analysis

4.5.1: The effectiveness of AI-based problem-solving tools in improving students' mathematical problem-solving

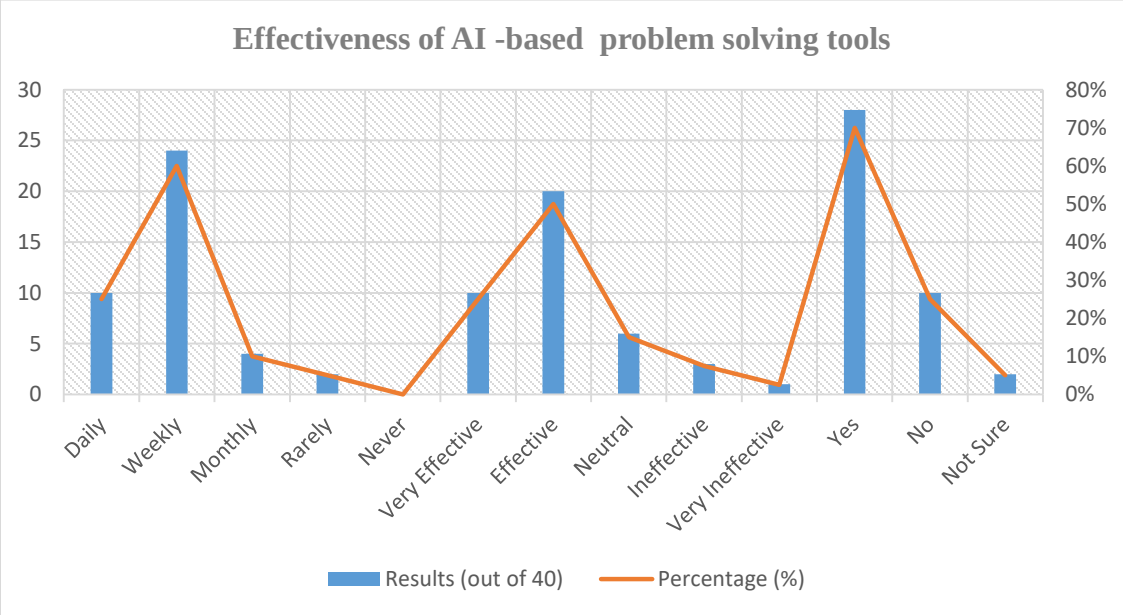

Figure1.0: shows results of *the effectiveness of AI-based problem-solving tools in improving students' mathematical problem-solving*

The analysis of the data regarding the use of AI-based problem-solving tools reveals significant insights into their effectiveness in enhancing students' mathematical skills. A notable 60% of students reported using these tools on a weekly basis, indicating a robust integration into their study routines. This frequency of use aligns with Hattie's (2009) assertion that regular engagement

with educational technologies correlates with improved learning outcomes. However, the effectiveness of such tools is a topic of ongoing debate.

While 75% of respondents rated the tools as either "Effective" or "Very Effective," suggesting a positive perception of their contribution to skill enhancement, this perspective is not universally accepted. Kay and Knaack (2008) argue that technology can indeed foster deeper understanding and retention of concepts, yet Clark and Mayer (2016) caution that without proper pedagogical integration, technology may lead to superficial learning. This contradiction highlights a critical point: the mere presence of technology does not guarantee educational success; rather, its effectiveness hinges on how it is implemented within the curriculum.

Further supporting the potential benefits, 70% of students indicated an improvement in their grades, reinforcing the notion that effective use of AI tools can lead to better academic performance (Schmid et al., 2014). However, insights from two interviewed mathematics teachers reveal significant challenges. One teacher expressed concern about students' frequent technical issues, stating, “While AI tools can enhance learning, students often struggle with technical problems that hinder their progress.” This sentiment is echoed by the other educator, who emphasized the necessity of adequate training for both teachers and students: “It’s crucial that we receive proper training to maximize these resources effectively”, Zheng et al. (2016).

Moreover, research by Zheng et al. (2016) supports the idea that technology can significantly enhance student engagement, yet without addressing the barriers highlighted by teachers and students, the potential of these tools may remain unfulfilled. The literature indicates that technology must be coupled with comprehensive training and support systems to realize its full benefits (Ertmer & Ottenbreit-Leftwich, 2010).

In conclusion, while AI-based problem-solving tools show promise in improving students' mathematical problem-solving abilities, the challenges and contradictions within the literature emphasize the need for strategic implementation and ongoing support. Addressing these issues could enhance the positive impact of AI technologies in educational settings, ensuring that they serve as effective catalysts for learning rather than mere distractions.

4.5.2: The impact of AI-based tools on fostering critical thinking and logical reasoning among ordinary-level mathematics students

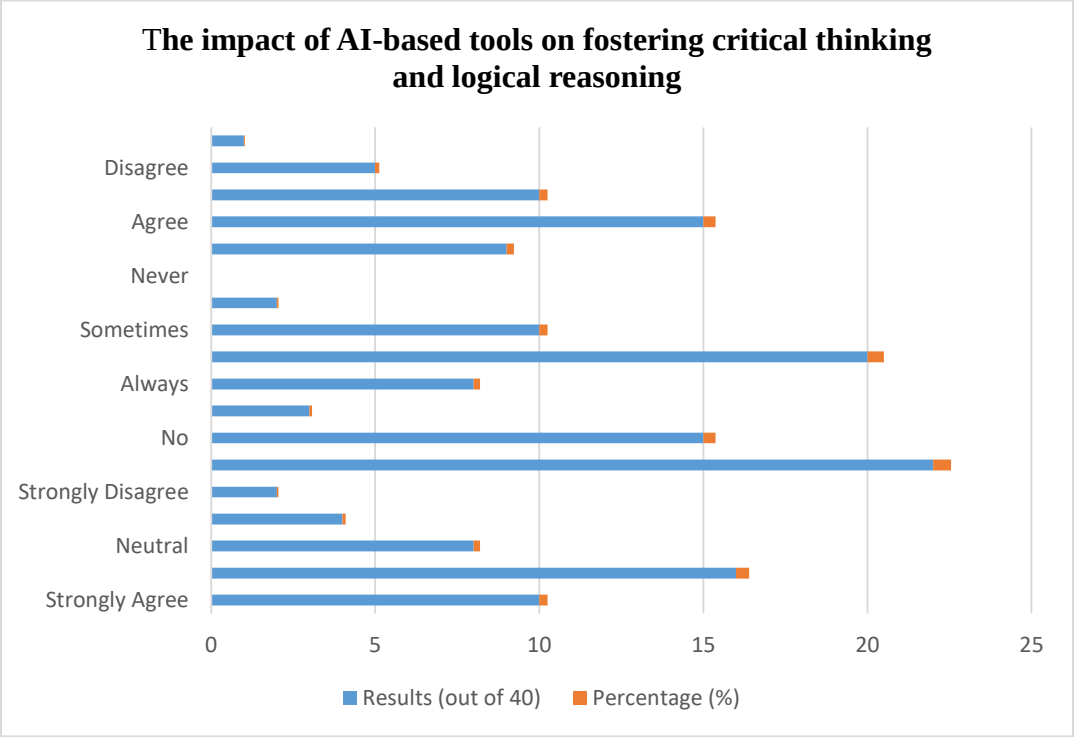

Figure 2.0: results on the impact of AI-based tools on fostering critical thinking and logical reasoning

According to figure 2.0 data analysis regarding students' perceptions of AI-based problem-solving tools reveals both supportive and contradictory findings in line with the objective of evaluating their effectiveness in enhancing critical thinking and problem-solving skills.

Starting with the results, 65% of students either "Strongly Agree" or "Agree" that these tools enhance their critical thinking abilities. This aligns with the findings of Hattie (2009), who emphasizes the importance of engaging students in higher-order thinking through technology. Moreover, the data indicates that 55% of students reported improvements in logical reasoning skills, reinforcing the notion that AI tools can facilitate deeper cognitive engagement (Zheng et al., 2016).

However, it's important to consider the contrasting views in the literature. While many studies highlight the potential benefits of technology in education, others caution that it can lead to superficial engagement if not implemented effectively. For instance, Clark and Mayer (2016)

argue that technology can distract rather than enhance learning, particularly if students lack the necessary skills to use these tools critically. This concern is reflected in the data, where 20% of students remained neutral or disagreed about the effectiveness of the tools, indicating a level of skepticism that aligns with Clark and Mayer's assertions.

Additionally, the frequency of critical thinking encouragement is noteworthy, with 70% of students reporting that they are encouraged to think critically "Often" or "Always." This finding supports the argument by Ertmer and Ottenbreit-Leftwich (2010) that effective integration of technology can foster an environment conducive to critical thinking. However, the responses also suggest that a significant portion of students feels this encouragement is not consistent or pervasive enough, as evidenced by the 25% who indicated they are encouraged "Sometimes" or "Rarely."

The qualitative insights from the two interviewed mathematics teachers provide further context. One teacher noted that while AI tools have the potential to enhance learning, technical issues often disrupt the learning process. This sentiment reflects the concerns raised by other researchers about the necessity of adequate training and support for both students and educators to maximize the benefits of technology (Ertmer & Ottenbreit-Leftwich, 2010).

In conclusion, while the data suggests a generally positive perception of AI-based problem-solving tools in enhancing critical thinking and logical reasoning, the contradictions in the literature highlight the importance of effective implementation and ongoing support. Addressing these challenges is essential for fully realizing the potential of AI technologies in educational settings

4.5.3 The challenges and opportunities associated with implementing AI-based problem-solving tools in semi-urban and rural schools

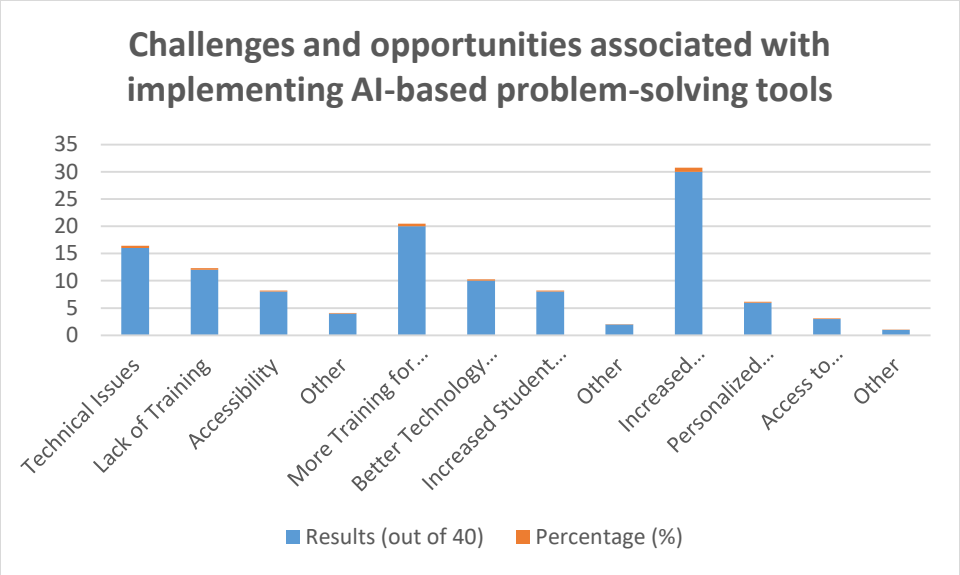

Figure 3: shows results of the challenges and opportunities associated with implementing AI-based problem-solving tools

The analysis of the data regarding challenges, necessary support, and opportunities for learning enhancement with AI-based problem-solving tools reveals a nuanced view of their implementation in education.

Firstly, the data indicates that 40% of students face technical issues, while 30% report a lack of training as significant challenges. This finding aligns with the research of Ertmer and Ottenbreit-Leftwich (2010), who emphasize that insufficient training can prevent effective utilization of technology. Without proper guidance, the potential benefits of these tools may not be fully realized. Clark and Mayer (2016) further argue that technology can distract rather than enhance learning when users lack adequate preparation.

The necessity for more training for teachers is underscored by the data, with 50% of students indicating that this is essential for effective tool usage. This perspective is reinforced by Hattie (2009), who highlights the importance of professional development in maximizing student engagement and learning outcomes. However, only 25% of students noted the need for better technology resources, suggesting a greater focus on human factors like training rather than solely on infrastructure.

In terms of opportunities for learning enhancement, 75% of students reported increased engagement as a primary benefit of using these tools. This supports the findings of Zheng et al. (2016), who assert that thoughtfully integrated technology can significantly boost student engagement. However, the relatively low percentages for personalized learning (15%) and access to additional resources (7%) indicate that while engagement is high, the depth of learning experiences may still be lacking.

Insights from interviews with two mathematics teachers further illuminate these challenges. One teacher expressed concern about the technical issues students frequently encounter, stating, “Students often struggle with connectivity and software glitches, which interrupts their learning.” Another educator emphasized the critical need for training, asserting, "Without proper training, both students and teachers can feel overwhelmed by the technology, which can hinder its effectiveness." These comments highlight the necessity of addressing both technical challenges and the need for comprehensive training.

Moreover, the data shows that 20% of students expressed concerns about accessibility, underscoring the importance of equitable access to technology. This aligns with Warschauer's (2004) assertion that disparities in technology access can exacerbate existing educational inequalities.

In conclusion, while AI-based problem-solving tools offer substantial opportunities for enhancing learning, the challenges and support needs highlighted in the data point to a critical need for targeted interventions. Addressing technical issues and implementing robust training programs will be essential for fully realizing the potential of these technologies in educational settings

4.6 Conclusion

In conclusion, the analysis of the three objectives concerning the use of AI-based problem-solving tools in education highlights both their potential benefits and the challenges that must be addressed for effective implementation. The data illustrates a generally positive perception among students regarding enhancements in critical thinking and engagement, with significant improvements in academic performance noted by many. However, the challenges of technical issues, lack of training, and accessibility remain critical barriers that hinder optimal use. Insights from

mathematics teachers further emphasize the need for comprehensive training and support to maximize the effectiveness of these tools. Overall, while AI technologies present substantial opportunities for educational enhancement, targeted interventions and a focus on equitable access are essential to fully realize their potential in fostering meaningful learning experiences

CHAPTER 5

RECOMMENDATIONS AND CONCLUSION

5.0 Conclusion

In conclusion, this project has thoroughly examined the implementation and impact of AI-based problem-solving tools in education, focusing on critical thinking enhancement, skill development, and the challenges faced by students and teachers. The findings reveal a generally positive perception among students regarding the effectiveness of these tools, with 65% reporting enhancements in critical thinking and 70% noting improvements in academic performance. Moreover, **75%** of students indicated increased engagement, highlighting the potential of AI tools to foster a more interactive and stimulating learning environment. However, the analysis also uncovers substantial challenges, including 40% of students facing technical issues, 30% experiencing a lack of training, and 20% citing accessibility concerns, all of which can impede the effective use of these technologies. Insights from mathematics teachers further emphasize the necessity of comprehensive professional development, with 50% of students advocating for more training for educators to maximize the benefits of these tools.

The qualitative feedback from teachers underscores the importance of addressing technical issues and providing adequate support to ensure that both students and educators feel confident in using AI resources effectively. Ultimately, while AI tools present promising opportunities for enriching the educational experience and fostering deeper learning, addressing the identified challenges and ensuring equitable access are crucial for fully realizing their potential. This project underscores the importance of a strategic approach to technology integration in education, one that prioritizes both the human and technological elements essential for success. Focusing on training, resources, and tailored support, educators can create an environment where AI tools not only enhance learning but also empower students to become more engaged, independent, and critical thinkers. The findings suggest that with the right strategies in place, AI technologies can transform educational practices and outcomes, paving the way for a more innovative and inclusive future in education.

5.1 Recommendations

To enhance the effectiveness of AI-based problem-solving tools in education, several key recommendations emerge from the project findings. First, it is essential to develop comprehensive professional development programs for teachers focused on both the technical skills and pedagogical strategies necessary for effective integration of these technologies in the classroom. Establishing robust technical support systems will help address common issues faced by students and educators, minimizing disruptions and enhancing the learning experience. Furthermore, ensuring equitable access to AI tools and technology resources is crucial; this may involve providing devices to underprivileged students and improving internet connectivity in schools. Regular feedback mechanisms should be implemented to gather insights from students and teachers about their experiences, guiding continuous improvements in training and technology use.

Additionally, fostering collaborative learning environments where students can work together using AI tools can enhance engagement and promote critical thinking. It is also vital that AI tools are integrated into the curriculum in a manner that complements traditional teaching methods, focusing on enhancing critical thinking and problem-solving skills. Monitoring and evaluating the effectiveness of these tools in improving student engagement and academic performance will help identify best practices and areas needing improvement. Lastly, promoting awareness and understanding of the benefits and uses of AI tools among parents and the community can create a supportive environment for students.

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Appendix 1: Questioner

Questionnaire on AI-Based Problem-Solving Tools
Instructions

- Please answer each question honestly.
- Your responses will remain confidential and will be used for research purposes only.
- tick only one box and for open response sub- questions use the space provided

Section 1: Effectiveness of AI Tools

1. **How often do you use AI-based problem-solving tools in your mathematics classes?**
    - ☐ Daily
    - ☐ Weekly
    - ☐ Monthly
    - ☐ Rarely
    - ☐ Never

    Sub question:

    - **Which specific AI tools do you use most frequently?**
      (Open response: _____)
2. **How effective do you find AI-based tools in enhancing your mathematical problem-solving skills?**
    - ☐ Very Effective
    - ☐ Effective
    - ☐ Neutral
    - ☐ Ineffective
    - ☐ Very Ineffective

Sub question:

- **Can you provide an example of a specific skill that improved?**
  (Open response: _____)

3. **Have you experienced measurable improvements in your mathematics grades since using AI tools?**
   - ☐ Yes
   - ☐ No
   - ☐ Not Sure

Sub question:

- **If yes, please indicate the approximate percentage of improvement.**
  (Open response: _____)

4. **Do you feel more confident in solving mathematical problems after using these tools?**
   - ☐ Strongly Agree
   - ☐ Agree
   - ☐ Neutral
   - ☐ Disagree
   - ☐ Strongly Disagree

Sub question:

- **What specific aspects of confidence have changed?**
  (Open response: _____)

Section 2: Impact on Critical Thinking

5. **Do you believe that AI tools have enhanced your critical thinking skills?**

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neutral
- ☐ Disagree
- ☐ Strongly Disagree

Sub question:

- **In what ways have these tools contributed to your critical thinking?**
  (Open response: _____)

6. **Have you noticed an improvement in your logical reasoning skills since using AI tools?**
   - ☐ Yes
   - ☐ No
   - ☐ Not Sure

   Sub question:

   - **If yes, please describe how your logical reasoning has improved.**
     (Open response: _____)
7. **How often do AI tools encourage you to think critically about mathematical problems?**
   - ☐ Always
   - ☐ Often
   - ☐ Sometimes
   - ☐ Rarely
   - ☐ Never

Sub question:

- **Can you give an example of a situation where this occurred?**
  (Open response: _____)

8. **Do you feel that AI tools provide scenarios that require logical reasoning?**
   - ☐ Strongly Agree
   - ☐ Agree
   - ☐ Neutral
   - ☐ Disagree
   - ☐ Strongly Disagree

Sub question:

- **Please elaborate on your answer.**
  (Open response: _____)

Section 3: Challenges and Opportunities

9. **What challenges have you faced while using AI-based problem-solving tools?**
   - ☐ Technical Issues
   - ☐ Lack of Training
   - ☐ Accessibility
   - ☐ Other (Please specify: _____)

Sub question:

- **Can you provide an example of a specific challenge you encountered?**
  (Open response: _____)

10. **What support do you think is necessary to improve the use of AI tools in your school?**

- ☐ More Training for Teachers
- ☐ Better Technology Resources
- ☐ Increased Student Access
- ☐ Other (Please specify: _____)

Sub question:

- **How do you think this support can be implemented?**
  (Open response: _____)

11. **What opportunities do you see for enhancing learning with AI tools?**
    - ☐ Increased Engagement
    - ☐ Personalized Learning
    - ☐ Access to Additional Resources
    - ☐ Other (Please specify: _____)

    Sub question:

    - **Please elaborate on how these opportunities can benefit your education.**
      (Open response: _____)
12. **How likely are you to recommend AI tools to fellow students for improving their mathematics skills?**
    - ☐ Very Likely
    - ☐ Likely
    - ☐ Neutral
    - ☐ Unlikely
    - ☐ Very Unlikely

    Sub question:

- **What reasons would you give for your recommendation?**
  (Open response: _____)

Appendix 2: Interview questions

Questionnaire for Teachers

Instructions for Administration

- Ensure the participants understand the purpose of the questionnaire.
- Allow sufficient time for responses, encouraging detailed answers where applicable.
- Consider conducting follow-up interviews for in-depth discussions based on initial responses

1. Demographics
   a What grade level do you teach or are you in?
2. Experience with AI Tools
   a. Have you used AI-based problem-solving tools in your learning or teaching? (Yes / No)
   b. If yes, which specific tools have you used?
3. Perceived Effectiveness
   a. On a scale of 1 to 5, how effective do you believe AI tools are in enhancing mathematical problem-solving skills? (1 being not effective, 5 being very effective)
   b. Can you provide examples of how these tools have improved your or your students' problem-solving abilities?
4. Engagement and Motivation
   a. Do you feel that using AI tools increases your engagement in learning or teaching mathematics? (Yes / No)
   b. If yes, what features of the AI tools contribute most to this engagement?
5. Challenges Faced
   a. What challenges have you encountered while using AI-based tools? (Check all that apply: Technical issues, Lack of training, Accessibility issues, Other)
   b. Can you elaborate on any specific challenges you or your students have faced?

6. Training and Support
   a. Do you believe that more training is necessary for effective use of AI tools? (Yes / No)
   b. What type of training would you find most beneficial?
7. Personalization and Adaptability
   a. How well do you think AI tools adapt to individual learning needs? (Scale of 1 to 5)
   b. Can you share any experiences where personalized learning through AI tools made a difference?
8. Collaboration
   a. Have you noticed any changes in collaboration among students when using AI tools? (Yes / No)
   b. If yes, please describe these changes.
9. Future Use
   a. would you recommend the continued use of AI tools in mathematics education? (Yes / No)
   b. What improvements or additional features would you suggest for these tools?
10. Overall Impact
    a. On a scale of 1 to 5, how would you rate the overall impact of AI-based tools on your learning or teaching experience? (1 being minimal impact, 5 being significant impact)
    b. Any additional comments on your experience with AI tools in education?