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GEOGRAPHY TEACHERS' LEVEL OF PREPAREDNESS IN ARTIFICIAL INTELLIGENCE USE IN GEOGRAPHY TEACHING IN CHITUNGWIZA

BY

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APPROVAL FORM

The undersigned certify that they have read and recommend to Bindura University of Science Education for acceptance, a research project entitled: Geography teachers' level of preparedness in Artificial Intelligence use in Geography teaching in Chitungwiza. Submitted by Chipeture Luke L. (B226415A) in partial fulfilment of the requirements for the Master of Science Education degree in Geography.

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DECLARATION

I, Chipeture Luke L., hereby declared that, except for references to other people's work which have been duly acknowledged, this project is a result of my research and has neither in part nor in whole been presented in the education programme

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DEDICATION

I dedicate this Research project to my late beloved daughter Tinevimbo whose untimely death left me with many unanswered questions which I believe only God has the answers and to my wife Christine for her unwavering support during the darkest moments of my life.

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ABSTRACT

This study sought to establish Geography teachers' level of preparedness in the use of Artificial intelligence (AI) in geography education in Chitungwiza. As educational technologies rapidly evolve, the potential for AI to enhance teaching methodologies and learning outcomes is significant. However, the successful implementation of these technologies depends heavily on teachers' readiness and competence in utilizing them effectively. The study was grounded on the pragmatist paradigm and employed a mixed method approach. This design enabled the study to inherently exploit the use of both qualitative and quantitative analysis procedure. The sample comprised 30 participants who were selected using purposive sampling method. The data were collected through semi-structured questionnaire and in-depth interviews. Numerical data were analysed through the use of frequencies and percentages, with non-numerical data analysed according to emerging themes. From the analyzed and interpreted data, it was noted that the geography teachers' level of preparedness was a function of their proficiencies in AI. While some teachers demonstrate enthusiasm and a willingness to adopt AI, many express feelings of unpreparedness due to inadequate training programs and limited resources. The study concluded that geography teachers' level of preparedness to integrate AI was significantly low due to an array of factors that emerged. From this conclusion, the researcher recommends that continuous professional development for Geography teachers was indispensable to upskill and prepare them adequately to function in a fast-evolving digital world.

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1.1 Introduction to the study

The motivation behind this study is an ever increasing and booming technological advancement Vis a viz a seemingly lake of geography teacher preparedness to utilise these newer technologies. There is a host of relevant Artificial intelligence (AI) tools, though originally not meant for education, but recently being tailor-made to enhance pedagogical practices. The traditional pedagogical methodologies appear to cast a long shadow over newer technologies and a paradigm shift that has a potential to revolutionalise the teaching and learning of geography. Using a mixed method approach, the study focused on secondary schools in Chitungwiza Zimbabwe to assess geography teachers' level of preparedness on the use of AI tools in geography education. Below is a detailed description of all the steps that led to the final results and recommendations.

1.2 Background of the Study

Artificial Intelligence (AI) is a computer science discipline that focuses on developing computer systems that can perform tasks that require human intelligence (Huang et al., 2021). This includes the ability to learn from data, recognize patterns, make decisions, and complete complex tasks (Simon, 2019). One of the main approaches in AI is machine learning, which involves using algorithms to teach a computer how to process data and take action based on discovered patterns (Zawacki-Richter et al., 2019). This allows AI systems to continuously improve their performance over time.

In this era of rapid globalisation, technological advancements have virtually swept across the world, affecting every aspect of human life including education. Technology powered by AI is becoming increasingly significant in our daily lives, subtly altering our ways of thinking, behaving, and interacting with one another (Chen et al., 2020). Such technological innovations have, in recent decades, taken an unprecedented trajectory, revolutionising teaching and learning and ushering in new innovations that have the potential to take teaching and learning to higher dimensions. The adoption of artificial intelligence (AI) in education has attracted momentous attention in recent years, with an increasing number of organizations and educational institutions exploring the potential benefits of AI-driven technologies (Dwivedi et al., 2021; Su & Yang, 2022).

While AI has been around for nearly 60 years (UNESCO, 2019) it has nevertheless remained hitherto a fringe technology until recently due to widespread changes in recent years referred to as "the big leap". The integration of AI tools in education has been rapidly evolving, and has become significant in the field of education (Mampota & Kurata, 2023). It has the potential to revolutionize teaching and learning to align with the 21st century demands, transforming traditional teaching and learning methodologies across various subjects, including geography.

AI is quite unique and has a special application in geography education. By applying AI technology in geography education, teachers can tailor make learning materials that suit students' individual needs and interests (Simon, 2019). For instance, intelligent systems can analyse each student's learning progress and adapt learning content to suit their individual level of understanding. In the field of geography education, there are vast AI tools (Panigrahi, 2020). These tools can be leveraged by geography teachers to enhance their pedagogical practices. Artificial intelligence tools such as Natural Language Processing are relevant for learners for enhancing research skills. According to Lunga (2019) students can use AI to analyse texts and extract relevant geographical information from various sources. Interactive AI tools like ChatGPT can answer students' questions about geographical concepts, providing a more interactive learning experience (Nguyen et al., 2023). Geographical Information Systems (GIS) has, in recent years, emerged as a powerful tool for geography education, allowing students to visualise and interpret spatial data. Through Virtual and Augmented Reality, Lunga (2019) pointed out that, AI can create virtual field trips affording students to experience geographical concepts whilst in the classroom.

The growing scepticism with regards to the use of AI in education is a function of hegemonic traditional pedagogical practices that cantered on the role of the teacher as a knowledge hub (Meaney, 2023). However, with the new trends in the development of AI and its adoption and usage in education and particularly geography education the new normal is inevitable. Mhishi et al (2023) says that, in face of the inevitable teacher role evolution, teachers are expected to adapt to the new normal, thus from being mere transmitters of knowledge to new responsibilities ushered by these technologies.

On the other hand, AI technologies have been progressively altering the role of teachers in teaching and learning (Wang et al., 2021). The introduction of AI has led to a redefinition of the teacher's role (Rakuasa, 2023). There seems to be a progressive transition or shift from traditional lectures

to facilitators of personalised learning with an emphasis on creativity. A shift in pedagogical approach ushered by the advent of AI has also challenged traditional pedagogical paradigms (Dong, 2024). Dinçer (2024) says that, the promotion of technology in the school system is one area that has not been commensurate to the fast-evolving world of technology. It is against this background that this study sought to gain insight into the level of Geography teachers' readiness on the use of AI tools in teaching and learning.

1.3 Statement of the Problem

Despite the potential benefits of AI tools in geography education, there is scarce research on the preparedness of Geography teachers to effectively utilize these technologies in secondary schools, particularly in developing countries like Zimbabwe. There is an increasingly widening gap between the rapid progression of AI tools, and the potential relative to Geography teachers' preparedness to use them in teaching and learning. It is in this context that this study was guided by the following main objective: To establish the teachers' level of preparedness in the AI use in Geography teaching and learning.

1.4 Research Objectives

This study was guided by the following sub-objectives:

1. To establish the teachers' understanding of AI tools in the context of Geography teaching and learning.
2. To describe how teachers are using the AI tools in Geography teaching and learning.
3. To identify the challenges faced by teachers when using AI tools in Geography teaching and learning.
4. To identify possible solutions to the challenges faced when using AI tools in Geography teaching and learning.

1.5 Research Questions

To achieve the above objectives, this study will address the following research questions:

1. What are the teachers' understanding of AI tools in the context of Geography teaching and learning?
2. How are teachers using AI tools in Geography teaching and learning?
3. What challenges are faced by teachers when using AI tools in Geography teaching and learning?
4. What possible solutions can be advanced to minimise the challenges faced when using AI tools in Geography teaching and learning?

1.6 Significance of the Study

This study holds significant importance for various stakeholders in the education sector:

1.6.1 Policymakers

The study will help policymakers in informed decision making. Currently in the Zimbabwe education system, there seems to be a mismatch between policy and practice, whereby the dictates and or requirements of the curriculum packages are divorced from learning outcomes and market expectations. The findings will inform educational policies and strategies for integrating AI tools in geography education and teacher training programs. By understanding the gaps in teacher preparedness, policymakers can allocate resources more effectively, ensuring ta schools have the necessary tools and support for AI implementation.

1.6.2 School administrators

The results will guide decision-making regarding resource allocation and infrastructure development to support AI integration in schools. The findings can guide school administrators in designing professional development initiatives that focus on equipping teachers with skills needed to effectively use AI in their teaching. These professional development initiatives will help close the ever-increasing skills gap and align teaching and learning outcomes with the market requirements.

1.6.3 Teachers

The study will highlight areas for professional development and provide insights into effective practices for incorporating AI tools in geography teaching. The study will help teachers to identify their own preparedness levels and areas needing improvement, allowing them to seek professional development opportunities.

1.6.4 Students

Ultimately, students will benefit from more engaging and effective geography education that leverages the power of AI technologies. This study is capable of improving learning outcomes in learners. By enhancing teacher preparedness with AI tools students can experience more engaging and personalised learning, leading to better understanding and retention of geographical concepts. Also, the exposure to AI tools in geography classes prepares students for future academic and carrier opportunities in a technology-driven economy.

1.6.5 Researchers

This study will contribute to the growing body of knowledge on AI in education and serve as a foundation for future research in this field. The study will form a baseline or foundation for further studies in the field of geography education particularly in the context of AI in various subjects. More so, researchers can identify trends in teacher preparedness and AI usage, contributing to the broader discourse on educational technology and its impact on teaching and learning practice.

1.7 Delimitation of the study

This study will focus on secondary school geography teachers in Chitungwiza, Zimbabwe. The research will primarily evaluate geography teachers' preparedness on the use of AI based on their self-reported knowledge, skills, and attitudes, as well as observations. The study will also concentrate on the specific AI tools currently in use or relevant to geography education, rather than a comprehensive review of all technologies available.

1.8 Limitations of the study

While the findings may have broader implications, they may not be fully generalizable to other regions or countries due to differences in educational systems, resources, and cultural contexts. Rapidly changing technological landscape may result in results becoming outdated quickly, limiting the long-term applicability of the research results. The size of the sample may fail to adequately represent the diversity of Geography teachers in Chitungwiza, potentially affecting the generalizability of the research findings.

1.9 Definition of Key Terms

The following key terms are defined contextually:

1.9.1 Artificial Intelligence

The European Commission (2020) states that AI systems are software (or software running on hardware) that, to some extent, mimic human cognition to perform tasks and can improve themselves based on the information they collect. This definition considers the self-improving aspect of AI. The simulation of human intelligence processes by machines, especially computer systems.

1.9.2 AI tools

Software applications or systems that utilize artificial intelligence technologies to perform tasks or assist in various processes. European Commission (2020) describes AI tools as software solutions that can perform tasks in a way that appears intelligent, often by learning from data to perform specific tasks.

1.9.3 Geography teaching and learning

The teaching and learning of geographical concepts, skills, and knowledge at the secondary school level. Smith and Dwyer (2001) describe geography education as an interdisciplinary field that integrates physical and human geography, promoting an understanding of the complexities of the Earth's systems and human-environment interactions. It aims to develop students' ability to think spatially and critically about the world around them, fostering both local and global awareness.

1.9.4 Teacher preparedness

The readiness of teachers in terms of knowledge, skills, attitudes, and access to resources necessary to effectively integrate AI tools into their teaching practices. Ertmer and Ottenbreit-Leftwich (2010**)** concurs and say that, it refers to the combination of knowledge, skills, and attitudes that educators possess, enabling them to effectively integrate technology, including AI, into their teaching practices.

1.10 Chapters layout

The dissertation was structured as follows

Chapter 1: This chapter discusses the background of the study, problem statement, and justification of study, research aim and objectives. This chapter also discusses the introduction of study.

Chapter 2: This chapter focusses on the review of related literatures on the state of geography teacher's preparedness on AI use in the teaching and learning of geography. The chapter focuses on the trends on AI usage in the subject of geography, the varied views, opinions, thoughts of different scholars on AI adoption and usage in geography education. Discussions of relevant concepts, theories and models are done in this chapter. In addition, gaps in the existing literature and body of knowledge will be exposed in this chapter.

Chapter 3: This chapter describes the methods used to obtain data for the research. Research instruments used to find solutions to the problems will be given in this chapter. Also, of importance, sampling technique will be described and reasons for the use.

Chapter 4: Data presentations and analysis of findings are discussed in this chapter.

Chapter 5: Conclusions and recommendations drawn from the study findings in line with the problem statement will be discussed.

1.11 Chapter summary

This chapter has introduced the background of the study, highlighting the potential of AI tools in geography education. It has outlined the research problem, purpose, objectives, and questions that will guide this study. The significance of the research for various stakeholders has been discussed, along with the scope and limitations of the study. Key terms have been defined to provide clarity for the subsequent chapters. The following chapter will review relevant literature to provide a theoretical foundation for the study

CHAPTER TWO: REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter reviews existing literature on the use of AI tools in education, with a particular focus on geography teaching and learning. It explores the theoretical frameworks surrounding technology integration in education, the current state of AI in the classroom, AI tools available, the challenges that geography teachers face in AI integration, the professional development needs required and their level of preparedness in using AI. The chapter aims to contextualize the study within the broader educational landscape and highlight gaps in research that this study seeks to address.

2.2 Theoretical framework

The study was guided by two theoretical frameworks, the Technological Pedagogical Content Knowledge (TPACK) and The Technology Acceptance Model (TAM). This framework builds on Lee Shulman's construct of pedagogical content knowledge (PCK) to include technology knowledge (Yani et al., 2021). The development of TPACK by teachers is critical to effective teaching with technology. Technology in Mishra and Koehler (2006) framework is not restricted to any specific technology, but in this study, the researcher refer specifically to Artificial intelligence. Yani et al (2021) posits that, what teachers need to know to integrate technology effectively into their teaching practices is characterized by three broad knowledge bases – technology, pedagogy, and content and the interactions between and among these knowledge bases (Koehler & Mishra, 2009). The framework emphasizes the interplay between three primary components:

2.2.1 Technological Pedagogical Content Knowledge (TPACK)

2.2.1.1 Content Knowledge (CK)

This refers to the knowledge of the subject matter that teachers are teaching (Smit et al., 2013). In geography education, this would include understanding geographical concepts, theories, and facts. Bengel & Peter, (2021) posits that, the main focus of geography is to recognize, understand, and evaluate the central economical, ecological, and societal challenges of mankind like climate change, migration diseases, hunger and many other social ills. Therefore, geography, like no other

subject, has the potential to capture and address the constantly evolving, technologically framed human-environment relationships in all their complexity. According to Jacob and Gwany (2020), a strong proficiency and foundation in content knowledge enables teachers to convey accurate information and engage students in meaningful discussions about the subject.

Geography education has to do with both the physical and the human environment, and most importantly the spatial relationships between the two realms (Adam 2020). The teacher must be well acquainted with the aspects, theories and facts about different phenomena in space. Content knowledge is important because it determines the discipline-specific modes of thinking unique to each field (Mishra & Koehler, 2008).

2.2.1.2 Pedagogical Knowledge (PK)

Mensah (2023) highlighted that PK encompasses the knowledge of teaching methods, strategies, and practices. It includes understanding how students learn and how to effectively facilitate that learning. According to Mishra and Koehler (2008), PK encompasses a set of skills that teachers must develop in order to manage and organize teaching and learning activities for intended learning outcomes. Mensah (2023) observes that, effective pedagogy helps teachers' select appropriate instructional strategies that engage students and cater to diverse learning styles. Yani et al (2019) concurs and posits that, it also involves a selection by geography teachers of proper AI tools for specific topics and concepts. In other words, PK addresses the question of which AI tool is relevant for which topic/concept. For instance, Volioti, et al (2022) say that AI-driven Virtual and Augmented Reality can be used to simulate real-world- environments which the teacher can use for students explore geographical locations and scenarios in a controlled, interactive setting, thereby enhancing engagement and understanding.

2.2.1.3 Technological Knowledge (TK)

According to Miller and Doering (2010), TK involves knowledge about various technologies, tools, and resources available for teaching and learning. It includes understanding how to use software, hardware, and online platforms. To date, there is an array of AI tools available for geography (Lee, 2023). Familiarity with technology enables teachers to select and integrate tools that enhance learning experiences (Fishman et al., 2016). This aspect of the TPACK theory is relevant and quite in synch with the geography education considering the abundance of

technological tools for use to enhance pedagogy. Tools such as the GIS has enabled the recording, analysis and manipulation of large amounts of geographic data, map analysis and visual displays (Scherer et al., 2019).

2.2.2 Technology Acceptance Model (TAM)

The TAM) helps to disentangle and understand how an individual's perceptions of a technology influence their attitudes and behavioural intentions, which in turn affect their actual use of the technology (Yi & Hwang, 2003). In educational research, the Technology Acceptance Model (TAM) is the most commonly used model to explain teachers' attitudes and behavioural intention to leverage on unique and newer technologies to support teaching activities (Al-Emran et al., 2018; Teo, 2019). The TAM posits that perceived ease of use and perceived usefulness significantly influence users' decisions to adopt new technologies (Rep & Blonder, 2024). In the context of geography education, this model can help explain teachers' willingness to integrate AI tools into their teaching practices. This holds true especially in geography education with a plethora of application software and hardware available for teaching various topics and concepts (Lee, 2023). Watson (2018) says that, usually, a teacher is comfortable with what they are used to whether teaching methods or aids, but when something new is introduced, anxiety sets in.

2.3 Conceptualising AI

Artificial intelligence (AI) definitions have multiplied and expanded over the years since the term was first coined. However, it has often been entangled with the philosophical questions of what constitutes 'intelligence' and whether machines can ever really be 'intelligent' (UNESCO, 2021). Artificial intelligence does not describe a single technology (Zawacki-Richter et al., 2019). It is a generic term used to describe a range of technologies and methods, such as machine learning, natural language processing, data mining, neural networks or an algorithm (Almelweth, 2022). Notwithstanding the abundance of these definitions, there appears to be inherently commonplace ideas as to what really constitutes AI. For instance, Luckin et al (2016) sees AI as computer systems that have been designed to interact with the world through capabilities that we usually think of as human.

A more detailed definition by COMEST (2019) views AI as tools capable of imitating certain functionalities of human intelligence, including such features as perception, learning, reasoning,

problem solving, language interaction, and even producing creative work. AI is a computer science discipline that focuses on developing computer systems that can perform tasks that require human intelligence (Huang et al., 2021). Pragmatically, sidestepping this long-running debate on the constituencies of AI it suffices to mention that AI involves endeavours to manipulate machines towards mimicking human intelligence faculties. Ultimately, the objective of AI is to develop a machine that can think like humans and mimic human behaviours, including perceiving, reasoning, learning, planning, predicting, and so on (Shabbir, 2018). The bulk of the consulted definitions obit around these human intelligence features of perception, learning, reasoning, language interaction and even creativity.

One of the main approaches in AI is machine learning, which involves using algorithms to teach a computer how to process data and take action based on discovered patterns (Zawacki-Richter et al., 2019). This allows AI systems to continuously improve their performance over time. In AI, research has focused mainly on the following components of intelligence: learning, reasoning, problem solving, perception and using language (UNESCO, 2019). Zawacki-Richter et al (2019) observed that there are two distinct types of AI, data-driven AI through Machine Learning and knowledge-based AI, based on an explicit representation of domain knowledge that a machine reason about. The current success of AI is mostly due to advances in data-driven AI (Ahmad et al., 2023). Conceptualizing AI involves understanding it as a branch of computer science that aims to create systems capable of performing tasks that typically require human intelligence. AI systems can learn from data, adapt to new inputs, and perform tasks with varying degrees of autonomy. Fig 2.1 below is an illustration of the relationship that exist among the three fields of AI.

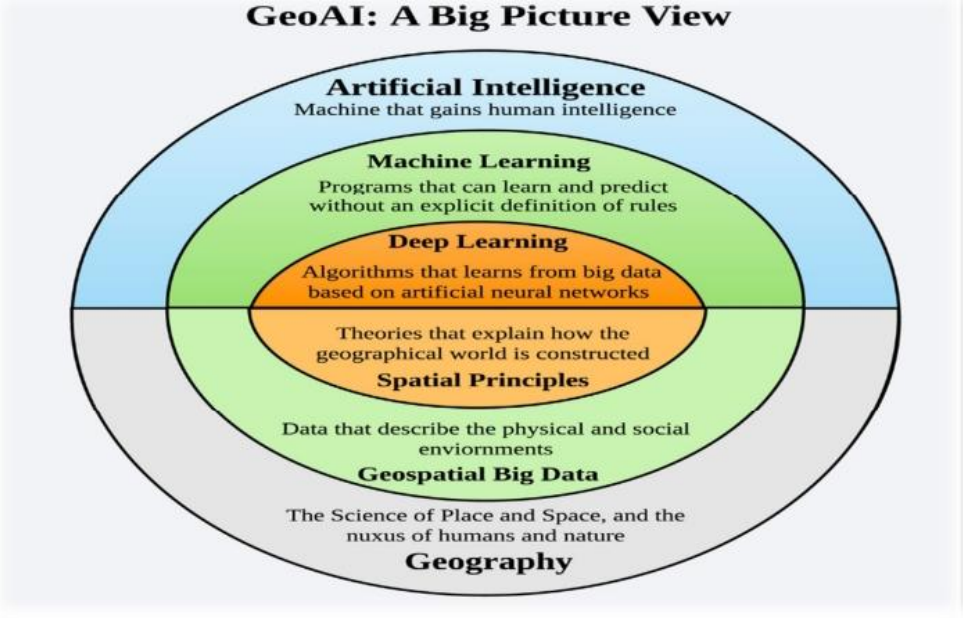

Fig 1: GeoAI: A big picture view (Mirislomov (n.d)

2.3.1 Machine Learning

Law et al (2024) defined Lachine Learning (ML) as a branch of AI that employs algorithms to identify patterns in data, continually enhancing the abilities of computerized machines to make informed decisions on unique situations based on fresh data and not necessarily pre-programmed. Popenici and Kerr (2017) define machine learning as a subfield of artificial intelligence that includes software able to recognise patterns, make predictions, and apply newly discovered patterns to situations that were not included or covered by their initial design. This seems to imply that machines can learn to read and understand human language and process an appropriate response upon request. It is a subset of AI that focuses on enabling machines to learn from data without being explicitly programmed (Michael, 2006). This involves developing algorithms that can recognize patterns, make predictions, and improve their performance over time (Ahmad et al., 2023).

Supervised learning, unsupervised learning, and reinforcement learning are common approaches in machine learning. Law et al (2024) coined the term ML, defining the concept as the ability to learn without being explicitly programmed. At its core, machine learning is simply a way to achieve AI. It is important to remark that one can get AI without using machine learning, but this

would require building millions of lines of codes with complex rules and decision-trees (Michael, 2006).

ML is increasingly recognised for its significant contributions to geography education, enhancing both teaching methodologies and learning outcomes. The application of ML in geography education provides students with practical experiences that connect theoretical knowledge to real-world scenarios (Law et al., 2024). For example, students can engage in projects that involve predicting environmental changes or analysing environmental changes or urban development patterns using ML algorithms thereby enhancing their understanding of geographic concepts (Mrabet & Sliti, 2024).

ML allows for enhanced data analysis skills in geography education (Rakuasa, 2023). Kenna (2023) posits that, as geography increasingly relies on large datasets, teacher familiarity with ML techniques allows students to analyse spatial data effectively, fostering critical thinking and analytical skills vital in 21st job market. In the same vein, Rana and Bambri (2025) argues that, teachers can also leverage on ML to structure their teaching content and make it appealing and engaging for the students.

2.3.2 Deep learning

Deep learning is a specific subfield of machine learning, viz. a new take on learning representations from data that puts an emphasis on learning successive layers of increasingly meaningful representations (UNESCO, 2019). As a subset of machine learning it uses neural networks with multiple layers to extract high-level features from data (Law et al., 2024). Deep learning has been instrumental in advancing AI capabilities, particularly in areas such as image and speech recognition, natural language processing, and autonomous driving. In deep learning, the training process often entails the use of millions of records of existing data to train algorithms to find patterns with predictions on new data made using estimated models (Lunga, 2019). For example, a deep learning algorithm can be trained to recognise buildings from a satellite image. Lunga (2019) says that, this is achieved providing by many examples images whose pixels are labelled to denote either having a building or not building. Deep learning thus can be seen at work in supervised and unsupervised image classification operations in GIS.

In Geography teaching and learning, the application of deep learning techniques, particularly GIS, allows for the analysis of complex geographic data through advanced computational methods.is quite relevant for the integration of advanced technologies (De Sabbata, 2022). Deep learning in geography education promotes interdisciplinary connections between Geography and other disciplines such as environmental science, urban planning and public health, demography, sustainability and resilience (De Sabbata, 2022). This interdisciplinary approach helps students understand the relevance of geographic concepts in real world contexts and encourages critical thinking and societal issues (Yu & Lu, 2021).

Furthermore, deep learning framework such as the APOS theory, (Action, Process, Object Schema), can be utilised to deepen student' understanding of geographic concepts (De Sabbata, 2022). Teachers can structure learning around these stages and facilitate a more profound grasp of topics like water cycle. Deep learning also promotes active learning (Yuan et al., 2024). Traditional geography teaching often relies on passive learning methods, whereby students were merely recipients of information (Schultz & De Mers, 2020). This concurs with Kenna (2017) who observed that there is a shift towards active engagement as students are actively engaged in cognitive processes of understanding and applying geographic concepts.

2.3.3 Natural Language Processing

Natural language processing (NLP) is a sub-field of AI that focuses on enabling computers to understand, interpret, and generate human language. Computerised machines can use complex algorithms and neural networks to learn natural human language and thus can effectively communicate with students and teachers who may not know anything about Boolean algebra. Computerised machines can use complex algorithms and neural networks to learn natural human language and thus can effectively communicate with students and teachers who may not know anything about Boolean algebra (Hlongwane et al., 2024). Computer systems can access information from the cloud and process it to create personalised teaching and learning content, thus can act as chatbots or also called virtual assistants in various subject matter (Reiss, 2021). NLP techniques are used in applications like language translation, sentiment analysis, chatbots, and voice assistants.

2.3.4 AI ethical and social implications

AI is gaining prominence in various sectors of the economy, education and social lives (Chen et al., 2020). However, As AI tools have become more prevalent, there are growing concerns about ethical issues such as bias in AI algorithms, data privacy, job displacement due to automation, and the impact of AI on society (Zaman, 2023). According to Ferrer et al (2021), bias and discrimination are potential areas of concern as they can permeate diverse sectors, including medicine. Since AI relies on 'big data', should AI systems be trained on biased data, they could perpetuate healthcare disparities, potentially leading to disastrous unequal access to high-quality medical care (Reiss, 2021). The same can be said with geographic information. The emergence of ubiquitous sensors and user-generated content on the Web allows large amounts of data to be generated and collected at a rapid pace (Mirislomov, 2014). AI systems often draw from historical data that may harbour inherent biases, resulting in discriminatory outcomes. Glauner et al (2018) acknowledged that, should then this "big data" carry some biases, the ensuing conclusions, theories and decisions could be equally erroneous and disastrous as well. Another major concern raised especially within the education fraternity is about data and privacy security (Elliott & Soifer, 2022). AI heavily relies on vast amounts of data, often of a personal and sensitive nature. The widespread adoption of AI raises concerns regarding data privacy and security. Students may unknowingly divulge personal information to AI systems, which could potentially be exploited or misused (Farayola et al., 2024).

2.4 AI applications in teaching and learning

Real-world applications of AI are becoming increasingly pervasive and disruptive, with well-known examples ranging from automatic translation between languages and automatic facial recognition (UNESCO, 2021). AI tools in teaching and learning have become one of the current emerging fields of unique educational technology (Wang et al., 2021). The application of AI in education has been the subject of research for about 30 years (Zawacki et al., 2019). However, on a broader scale, educators have just started to explore the potential pedagogical opportunities that AI applications afford for supporting students. Luckin et al (2016) identified three categories of AI software applications that are available in education today: a) personal tutors, b) intelligent support for collaborative learning, and c) intelligent virtual reality. Intelligent tutoring systems are based on learner models algorithms and neural networks. They are capable of individualising the

learning path of a student, making decisions on content selection and also provide cognitive scaffolding and help, to engage the student in dialogue (Idowu, 2024). Intelligent tutoring systems offers a wide range of opportunities especially for distance education where human one-to-one tutoring is impossible. However, Salmon, (2000) says that facilitation and moderation is needed in such scenarios.

The pervasive tentacles of artificial intelligence have inevitably affected education offering new opportunities and transforming pedagogical practices (Rakuasa & Latue 2023). In essence, Geography learning has a central role in helping students understand the complexity of interactions between humans and the environment specifically as the world is reeling at the unrelenting effects of climate change. Along with technological advancements, especially in the field of Artificial Intelligence (AI), opportunities arise to integrate this technology in the Geography learning process (Chang & Kidman, 2023). GIS tools are pivotal in geography education, allowing students to visualize, analyse, and interpret spatial data (Costa, 2024). AI tools enhance GIS capabilities through functions such as data analysis (Huang et al., 2021). AI algorithms has the ability to analyse large volumes of geographic data, identify patterns, and draw deep insights into geographical phenomena such as environmental changes, population movement (Muin & Rakuasa, 2023. In GIS, predictive modelling makes use of Machine learning techniques to predict environmental changes, urban development, and disaster management scenarios based on historical data (Lunga, 2019). This can help in understanding the impact of climate change, anticipating natural disasters, and forecasting changes in human migration patterns (Rakuasa, 2022). AI-enhanced geographic data analysis provides more accurate and rapid insights, which enables better decision-making in a variety of areas, including the environment and public welfare (Hehanussa et al., 2023; Muin & Rakuasa, 2023).

2.5 Teachers' preparedness for AI use in teaching and learning

The Geography teachers' preparedness to use AI in teaching obits around several factors. Below are some of the intrinsic and extrinsic factors that either promote of hinder the integration of AI in the teaching of geography.

2.5.1 Knowledge and skills

Chounta and Avouris, (2016) suggest that a lack of training and digital literacy among teachers can impede the successful integration of AI tools. Ongoing professional development is crucial for equipping teachers with the necessary competencies to utilize AI in their teaching (Yıldırım & Ünlü, 2021). Generally, the preparedness of geography teachers to integrate artificial intelligence (AI) tools in the classroom is a function of their knowledge and skills. In addition, Chounta (2024) revealed that certain skills set are required for teaching in a changing global village to accommodate the needs of an IT-enhanced, data-literate society. This therefore serve as a suggestion for developing new standards for teaching qualifications. Several factors contribute to these relationships.

2.5.2 Technical proficiency

Geography teachers need a solid understanding of AI technologies and their applications in education. It includes understanding how to use software, hardware, and online platforms. Teachers who are technically proficient can effectively utilize AI tools to enhance their teaching methods, such as using AI for personalized learning experiences or data analysis in geography (Boen, 2023). Without this proficiency, teachers may struggle to implement AI effectively, leading to underutilization of available resources. According to the TPACK theory the interplay among the components of the theory that is Pedagogic Technical and Content knowledge is very crucial for AI use in geography education. In as much as the teacher may possess requisite content knowledge, they are often found wanting with regards to the necessary connections between the content and these other components; PK and TK.

2.5.3 Pedagogical knowledge

According to Koehler and Mishra, (2008), pedagogical knowledge involves, but is not limited to, an understanding of classroom management activities, the role of student motivation, lesson

planning, and assessment of learning. Pedagogical knowledge may also describe knowledge of different teaching methods, such as knowing how to organize activities in a way conducive to students' constructive building of knowledge (Koehler & Mishra, 2009). Celik (2023) concurs and points that, teachers must possess pedagogical skills that allow them to integrate AI tools into their lesson plans meaningfully. This includes understanding how to align AI applications with curriculum goals and student learning outcomes.

2.5.4 Continuous professional development

The continuous professional development needs of teachers, particularly in the context of artificial intelligence (AI), have been highlighted in various studies. According to Denga and Denga (2024) it is importance to equip teachers with the necessary skills and knowledge to effectively integrate AI into their teaching practices through ongoing training and professional development so that teachers stay updated on AI advancements and educational technologies. Singh & Mukeredzi (2024) noted that, many Geography teachers in indicated unprepared to integrate technology due to limited professional development opportunities. This lack of training can lead to resistance or reluctance to adopt AI tools, as teachers may feel overwhelmed or unsure about their implementation.

2.5.6 Adaptability and flexibility

In today's diverse classrooms, students come from various backgrounds with different learning styles and may require individualized support (Chifamba 2022). By being flexible and adaptable, teachers can create an inclusive and supportive learning environment where all students can thrive. By leveraging on AI tools, teachers can be able to personalize learning (Rakuasa, 2023). AI can analyse student behaviour and learning patterns through data, which allows for adaptation of learning according to individual needs and preferences (Zawacki-Richter et al., 2019).

With AI tools, teachers can tailor make learning materials, pedagogic methods, and task difficulty levels can be tailored to each student's learning preferences and characteristics (Rakuasa, 2023). AI has made individualisation of learning possible by use of intelligent tutoring systems. This helps to scaffold those students who lag behind to comprehend concepts and on the other hand relatively faster students can be given more challenging assignments (McNeil et al., 2006). This

personalization of improves learning efficiency and effectiveness, and motivates students to actively participate in the learning process (Alamri et al., 2020)

2.6 Challenges of AI Integration in teaching and learning

The rate at which technological innovations are altering the education landscape present challenges for geography teachers (Lambert, 2010). The integration of artificial intelligence (AI) in teaching and learning presents a transformative opportunity to enhance educational practices and outcomes. However, this shift is not without its challenges. Several studies have revealed that these challenges obit mainly around resource limitation (Eden et al 2024, Saputra et al 2023), insufficient infrastructure and lack of professional development.

2.6.1 Lack of resources

Jaramillo and Chiappe (2024) noted that, although teachers occupy a central position and are important agents in implementing curriculum packages, however, research indicates that they often struggle to implement curriculum reforms and lack adequate preparation, resources, and support. There is often a lack of access to AI tools and resources, such as software and hardware that are necessary for effective AI integration. Schools may not have the budget to purchase the latest technologies, which limits teachers' ability to experiment with and utilize AI in their teaching (Hlongwane et al., 2024). Lambert (2021) noted that, in well-resourced schools, students will have good access to technology in the classroom in form of tablets or via electronic classroom displays such digital projectors and smartboards.

2.6.2 Inadequate infrastructure

Many schools face significant infrastructural challenges, including inadequate access to reliable electricity and internet connectivity (AlAli & Wardat., 2024). Zawacki-Richter et al (2019) observed that not all schools or regions have adequate infrastructure to integrate Artificial Intelligence in Geography teaching and learning. Insufficient hardware, software, and internet connectivity can hinder teachers' ability to implement AI effectively. Mhishi et al (2023) observed that, there is a technological divide between the underdeveloped rural and urban schools with regards to internet penetration. This lack of internet connectivity and infrastructure hampers the effective use of AI tools, which often require stable internet and power sources to function optimally (Hlongwane et al., 2024).

2.6.3 Lack of training and continuous professional development

Geography teachers often lack the necessary training to effectively use AI tools in their classrooms. (Hlongwane et al., 2024). Teachers may not have adequate training in using AI tools effectively. A study by Chikoko et al (2020) found that many educators feel unprepared to integrate technology into their teaching practices due to limited professional development opportunities. Klein (2023) concurs that, professional development programs that focus on AI integration are scarce, leaving educators unprepared to leverage these technologies for enhanced teaching and learning. The major contributing factor being that majority of the teaching staff did their college training when these new technologies were still a foreign land in many universities and teacher training colleges (Chugh et al., 2023). This gap in training can lead to resistance or reluctance to adopt AI tools, as teachers may feel overwhelmed or unsure about how to implement them effectively (Varghese & Mandal 2020).

2.6.4 Curriculum constraints

Curriculum challenges are issues related to the development of learning materials that are compatible with AI technologies (Huang et al., 2021). The national curriculum has to be responsive to the rapidly changing technological landscape for it to remain relevant and meet the demands of the 21st century market (Kim & Seidman, 2019). However, developing engaging and relevant learning content requires sufficient time and resources (Zhai et al., 2021). The existing curriculum may not adequately support the integration of AI tools. Artificial Intelligence and Machine Learning are relatively new concepts to geography teachers and students as well Valender et al (2023), it is equally important to consider these when designing teacher education and teacher professional development in universities and teacher training colleges.

2.6.5 Resistance to change

UNESO (2019) acknowledged that since its very outset, AI in education has faced many difficulties in acceptance because education systems around the world are more reluctant to adopt newer technological changes in their traditional systems. One significant barrier to the adoption of AI in the classroom is the fear of change (Brown, 2024). She went on to say that, many teachers may feel apprehensive about incorporating new technologies into their teaching practices due to the uncertainty and disruption that change often brings. This fear of the unknown can manifest as

resistance to exploring unfamiliar tools and methods, as teachers may worry about their ability to adapt to new technologies and effectively integrate them into their instruction (Brown, 2024)

2.7 Chapter summary

The chapter reviewed related literature with regards to Artificial intelligence use in Geography education. The chapter introduced the TPACK and the TAM as theoretical frameworks and how these inform the study. Conceptualisation of AI have considered three broad areas that is ML, Deep learning, and AI. The study methodology that includes the research philosophy, approach, design and how data was collected and analysed, is contained in the next chapter.

CHAPTER 3: RESEARH METHODOLOGY

3.1 Introduction

The chapter also outlines the methodology that the researcher used to respond to the issue under investigation. The research design, participant selection, data collection methods, and data analysis procedures are detailed to ensure the study's rigor and validity. Lastly, the chapter summary was presented.

3.2 Research paradigm

A research paradigm according to Hargreaves and Fullan (2016) provides researchers with a framework for understanding and interpreting the world, and helps them make decisions about how to conduct their research. It can be defined as a set of beliefs, values, and assumptions that guide the research process (Babbie, 2016). This points to the assertion that the researcher's set of beliefs and values influence how they will perceive the environments and the world surrounding them, which in turn influence how knowledge is created and the process by which it is developed as the researcher undertakes the research investigation (Grossoehme, 2014). There are several different research paradigms, each, with its own strengths and weaknesses (Creswell, 2012). Hence, pragmatism paradigm is deemed relevant and strategically selected for this study. As a research paradigm, pragmatism has attracted attention in recent years due to its practical and flexible approach to research knowledge (Creswell, 2014).

The pragmatists' paradigm is rooted in the philosophy that knowledge and reality are a product of beliefs and habits that are socially constructed (Yefimov, 2004). This paradigm is grounded on the belief that people develop subjective meanings of their experiences, an approach that gives full weight age to individual differences which make them unique in sense of identity and personality (Grover, 2015). This view helps us to understand different dimensions and facets of a single phenomenon (Denzin & Lincolin, 2014; Lincolin & Guba, 2011). Thus, it adheres to the view that only factual knowledge gained through observation, including measurement is valid and reliable (Omari, 2016). Kothari (2014) further reports that in research methodology, pragmatism focuses on the importance of using a mix of qualitative and quantitative methods to address research questions and produce meaningful results. It was in the context of these facts about pragmatism as well as consideration of the main research objective that pragmatism is chosen as the research paradigm for this study. This is due to its openness to multiple ways of collecting and interpreting

truths and reality and thus giving vast opportunities to triangulate data for valid and reliable conclusions (King, 2022).

3.3 Research approach

According to Cresswell (2012), mixed method approaches are procedures for collecting, analysing and mixing both quantitative and qualitative data in a single study or in a multi-phase series of studies. In this data collection process, Mazhar et al (2021) say that the researcher needs to decide on the emphasis which would be given to each form of data, which form of data to be collected first, how the data is going to be mixed, and whether the researcher should use theories to guide the study. The study's main goal was addressed using an embedded mixed methods strategy. The convergence model represents the traditional model of a mixed methods triangulation design (Creswell, 2006). In this study, the researcher collected and analysed quantitative and qualitative data separately on the same phenomenon and then the different results are converged by comparing and contrasting the different results during the interpretation. Thus, this approach was used to compare and validate, confirm or corroborate quantitative results with qualitative findings. The method was efficient, since both types of data were collected during one phase of the research at roughly the same time.

Moreover, each data could be collected and analysed separately and independently, using the techniques traditionally associated with each data type (Mazhar et al., 2021). However, much effort and expertise were required, particularly because of the concurrent data collection and the fact that equal weight had to be given to each data type. The mixed method approach was chosen by the researcher because it improved the validity of the findings and recommendations (Pregoner, 2024). If mixed methods offer a better understanding of the research problem than a single method design, then it is worth considering (Bamberger, 2012).

3.4 Sample and sampling procedure

Sampling is an act, process or technique of selecting a representative part of the population for the purposes of determining parameters or characteristics of the whole population (Gentles et al., 2015). The target population for this study consisted of fifty Geography teachers from eleven schools randomly selected in Chitungwiza.

Table 3.1: Distribution of selected respondents (n= 30)

School	Total number of teachers	Number of selected teachers
A	6	4
B	4	2
C	4	2
D	8	4
E	10	7
F	8	5
G	4	2
H	2	1
I	3	2
J	1	1

A sample is a selection from or any part of a defined population (Canhao & Keogh, 2004). In other words, it is a portion of the population that has been collected for statistical analyses. According to Firomumwe (2018), it is a subset of the target population. A sample size of thirty (30) geography teachers was targeted for the study. In addition, Punch and Oancea (2014) acknowledged that a sample is the actual group who are included in the study and from whom the data are collected. Since 10% sample size is the general rule of thumb, the sample percentage of 60% was adequate. This size is deemed sufficient to achieve statistical significance and thematic saturation in qualitative data.

3.5 Instruments

Nyumba (2018) posits that, research instruments are tools used to obtain, measure, and analyse data from subjects around the research topic. Kaushik and Walsh (2019) explained that instruments are selected based on the type of study one is conducting: quantitative, qualitative, or mixed method.

3.5.1 Interview

Ruslin et al (2022) defined as face to face interactions in which one party seeks to extract views held by the other on a given issue. A semi-structured interview is a meeting between two parties, the interviewer and the interviewee, the objective being to gather information in tandem with a set of questions (Creswell, 2014). The themes covered in the interviews included the teachers understanding of AI in teaching and learning, challenges faced in integrating AI tools, and the possible solutions to these challenges. Sahoo (2022) identified advantages of using the interview as compared to the questionnaire. These include the fact that questionnaires are inappropriate to a highly illiterate population, whereas an interview is appropriate in this regard. Winwood, (2019) says that an interview is flexible since questions can be repeated or rephrased to ensure respondents understand what is really meant by a question. Thus, the interviewer is given access not only to hear what people say but how they say it. He also went on to indicate that, the non-verbal cues in an interview is an important aspect to be noted since they provide important information that cannot be obtained using questionnaires.

3.5.2 Semi-structured questionnaire

A questionnaire is defined as a set of written or printed questions with a choice of answers devised for the purposes of a survey or statistical study (Berggren, et al., 2024). It is a data gathering instrument through which respondents answer questions or respond to questions in writing (Aung et al., 2021). According to Cleave (2023), semi-structured questionnaire is a form of guided interviewing where only some or few of the questions are predetermined. It includes a mix of both closed and open-ended questions. The semi-structured questionnaire was employed because it has a number of advantages. According to Fife-Schaw (2020), semi-structured questionnaire is considered ‘the best of both worlds’ since it collects comparable and reliable data, and its flexibility to ask follow-up questions.

A questionnaire guarantees confidentiality or anonymity (Cleave 2023). It can be directly administered to a group assemble in a place thus at a mining area or at household level (Lindemann, 2023). It has a high response rate and the ease of reaching the participants. It also enables the researcher to collect data from people who are distant at the same time. The respondents were not influenced by the presence of the researcher, since they could answer questions during the researcher's absence. Moreover, data collected through a questionnaire is easy to analyse, since the majority of the questionnaire's items are yes/no and closed type. In this study, semi-structured questionnaire with a blend of structured and unstructured questions in a specific order were self-administered to Geography teachers.

3.6 Data collection procedure

The researcher obtained a letter from Bindura University of Science Education in order to obtain a research permit from the Ministry of Education to move around the schools. The introductory letter enabled the researcher to obtain permission from the Chitungwiza District Education Offices to carry out the study in secondary schools around Chitungwiza District. Upon being granted permission by the responsible authority, the researcher went around Schools seeking permission from school heads, deputies and principals. The researcher outlined the objectives of the study to the responsible authorities. The interview participants were selected purposively and the researcher personally interviewed them. The teachers were selected by convenience sampling and semi-structured questionnaires were distributed to them. The researcher orally explained to the participants the purpose of the study hence the need to diligently and meticulously complete the questionnaires. The researcher collected data using the semi-structured questionnaires, and personal interview guides. Thus, both quantitative and qualitative data was collected simultaneously with the assistance of the school heads and principals who would ensure that the questionnaires were completed timeously and provided suitable venues for the interviews.

3.7 Data analysis

Data analysis refers to the systematic process of examining, organizing, and interpreting raw data collected during a research study (Jung, 2019). It involves extracting relevant information from the gathered data to answer research questions or test hypotheses.

3.7.1 Quantitative data analysis

The quantitative aspect involves the use of structured surveys to gather data on teachers' knowledge, skills, attitudes, and experiences with AI tools (Skulmowski, 2025). The survey included Likert scale questions to quantify levels of readiness and comfort with AI technology (Adosi, 2020). According to Islam (2020), quantitative data analysis is a process of presenting numerical data. In this study, the researcher used descriptive statistics for quantitative data, which involved cleaning the data to make sure that the data were correctly identified in order to gain knowledge about the data. Numerical data were analysed in this study through frequencies and percentages, which was then presented in tables.

3.7.2 Qualitative data analysis

In-depth interviews were conducted to gain a deeper understanding of teachers' perceptions of AI tools in geography education. Each interview will be recorded (with consent) and transcribed for analysis. Qualitative data from interviews will be analyzed using thematic analysis. Transcriptions will be coded for emerging themes related to preparedness, challenges, and perceptions of AI tools. This process will involve multiple readings of the transcripts to ensure comprehensive understanding and accurate coding. Thematic data analysis was used to analyse qualitative data. According to Adams and McGuire (2022) thematic data analysis is a qualitative research method that involves systematically analysing and categorizing the data to identify patterns and themes within the data set. This approach allowed researcher to gain a deeper understanding of the underlying meanings and interpretations embedded within the data.

3.8 Research integrity

According to Mohajan (2017), research integrity refers to the ethical and professional standards that researchers must adhere to while conducting research. Madan and Kensinger (2017) coined that it encompasses both the scientific integrity of the research and the professional integrity of the researchers. Key elements of research integrity include honesty, rigour, transparency, and open communication, as well as care and respect for all participants and accountability (Roshaidai& Arifin, 2018). This section describes the research integrity used by the researcher.

3.8.1 Validity and reliability

In an effort to get accurate results, the researcher relied on content validity. The degree to which the questions on the test and the results from the questions accurately reflect all conceivable inquiries about the subject matter or competence is known as content validity (Patton, 2012). This made it easier for the researcher to confirm that the research captured the intended data.

This study attempted to achieve reliability by making the research procedure logical, traceable and clearly documented in a manner that other individuals from outside the research would be able to follow. Triangulation was also used to improve reliability (Best & Khan, 1993). Triangulation is the use of two or more methods of data collection in the study of some aspect of human behaviour (Cohen & Manion, 1994). Methodical triangulation is used where two methods, such as questionnaires and interviews, are used to collect information. The researcher used semi-structured interviews questionnaires as well as observation method to obtain data from geography teachers to ensure reliability.

3.8.2 Ethical considerations

Research ethics are moral principles that guide researchers to conduct research without deception or intention to harm the participants of the study or members of the society as a whole, whether knowingly or unknowingly. Each and every research has its ethical concerns to be considered. This research mainly focused on the ethics which include informed consent, voluntary participation of respondents, confidentiality, anonymity and protection from harm (Abdallah 2024).

3.8.2.1 Informed consent

Informed consent refers to the promise given by an individual to take part in a research study or any programme based on inclusive information regarding the nature of determination of the study or programme and their part in it (Skulmowski, 2025). The researcher explained the purpose of the research, the nature of the study, the benefits of the study, and risks if there are any. Therefore, anyone who was willing to participate after all this explanation was considered to have been given informed consent in the research.

3.8.2.2 Confidentiality

Confidentiality refers to the handling of information that an individual has revealed in a relationship of trust and with the anticipation that it would not be made known to others in ways that are unreliable with the understanding of the original expose without consent (Tan et al., 2024). Respondents' risk of social harm when private information become public were protected by making their responses unknown and confidential, that is by using no identifiable information such as the names of the participants (Whelan, 2007). Therefore, respondents were guaranteed confidentiality as the information gathered by the researcher was not revealed to anyone without their consent

3.9 Chapter summary

This chapter has detailed the methodology for evaluating geography teachers' preparedness for using AI tools in education. By employing a mixed-methods approach, the study aims to provide a holistic understanding of the current state of preparedness and identify areas for professional development and support. The subsequent chapters will present the findings and discussions derived from the data collected.

CHAPTER FOUR: DATA ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter presented and discussed the data generated from in-depth interviews and structured questionnaires, in line with the study aim and objectives, the research questions, and the problem statement. The aim of the study was to explore the state of preparedness of secondary school geography teachers with regards to the use of AI in Geography teaching in Chitungwiza. This chapter first presented the characteristics of research participants and the themes which include the AI tools available for geography education, challenges faced by geography teachers in integrating AI tools. Lastly, the chapter summary is presented.

4.2 Characteristics of the respondents

This section focused and presents the characteristics of the selected research respondents who were interviewed using semi-structured questionnaires and personal interviews. Such characteristics include research participants' sex, age, and professional qualifications, the levels they teach.

Table 4.1: Demographic characteristics of the selected respondents (n=30)

Attribute(s)	(n)	(%)
Sex		
Male	12	40
Female	18	60
Age range (years)		
Less than 30	1	3.33
30-40	16	53.3
40-50	9	30
50-60	4	13.3
60+	0	0
Professional qualifications		
Diploma in Education	6	20
Bachelor's Degree	20	66.7
Masters	3	10
PhD	1	3.3

Table 4.1 shows that most participants were females who constituted 60%, whilst males constituted 40%. Table 4.2 also shows that 3.3% of the participants were aged 30 years and below, 53.3% were aged 30-40 years, 30% were aged 40-50 years, and 13.3% were aged 50-60 years, whilst 0% 60 and above years respectively. The majority of the participants were therefore in the late maturity group above 45 years. In terms of professional qualifications, most geography teachers, 66.7% obtained a bachelors' degree in education, whilst 10% were have at least reached diploma level with a 10% at Masters level and 3.3% at PhD level. This is an indication that most of the Geography teachers were qualified enough to understand the AI significance in geography education.

4.3 Teachers' understanding of AI tools in the context of Geography teaching and learning

In this section, the results are presented under the theme geography teachers' understanding of AI tools in the context of geography teaching and learning. Table 4.2 below presents participants' understanding of AI tools usage in the context of geography education

Table 4.2 Geography teachers' understanding of AI tools (n=30)

Attributes	Strongly Agree		Agree		Disagree		Strongly Disagree	
	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
AI based lesson planning tools	1	3.3	3	10	20	66.7	6	20
Geographic information Systems	16	53.3	7	23.3	1	3.3	6	20
Data analysis tools	2	6.7	3	10	20	66.7	5	16.7
Educational chatbots	12	40	14	46.7	3	10	1	3.3

4.3.1 AI-based lesson planning tools

Table 4.2 shows that most participants (66.7%) had little understanding of AI tools with regards to Lesson planning, with a further 20% of the respondents indicating that they were strongly incompetent with regards to the use of AI in lesson planning, 10% indicated that they possess the request skills and knowledge hence understand, then lastly 3.3% indicated that they were conversant with AI-based lesson planning tools. Therefore, the presented statistics reveal that the majority of geography teachers, (86.7%) do not understand hence not competent in utilizing AI-based lesson panning tools. This concurs with the following in-depth personal interview response from geography teacher at one of the schools in Chitungwiza. One of the respondents indicated that:

> *We don't use any technology-based lesson planning tools in geography education, not because of the non-availability of such tools, but mere incompetence. At teacher-training colleges, we never heard of AI-based lesson planning tools as such we don't know how to utilize them* (Interviewee 1)

Another respondent shared the following sentiments:

> *The traditional pedagogic practices do not allow space for these newer technologies. We simply don't have the basic understanding on AI-based lesson planning tools even from*

> *college. The time that we attended college there was no artificial intelligence, it was unheard of during the early 90s* (Interviewee 4)

The deduction from the above analogue is that the participants lack basic knowledge on how AI can be leveraged in lesson planning. This concurs with Aljemeley (2024) who observed that there is a significant gap in training for geography teachers regarding AI technologies. He further points that many teachers feel unprepared to use AI tools effectively because they lack the necessary technical understanding of how the tools are used. This lack of understanding has the potential of leading to resistance against adopting AI in lesson planning. In Zimbabwe there is a general skills deficiency with regards to AI tools specifically for pedagogic purposes.

4.3.2 Geographic Information Systems

The table 4.2 shows that a greater proportion of the respondents that is 53.3% had an understanding of how GIS is used in geography teaching and learning. It also shows that another 23.3% of the participants were agree, 3.3% disagree, and 20% strongly disagree. The presented statistics therefore reveals that the majority of the subjects who responded to the questionnaire survey, 86.6% indicated that they understood how GIS is used in geography education. This is in tandem with some views from the in-depth personal interviews a respondent indicated that:

> *Geographic information system (GIS) is one of the common technologies that we use in geography education. It has been around for quite some time now and we've been teaching this since it's included in the geography syllabus. We don't have much challenges when it comes to this area* (Interviewee 5)

Another responded had this to say:

> *I learned GIS at college so I am very competent in this area. When this was introduced in the geography syllabus, at first there were some challenges in teaching this because it requires some strong internet connection and other electronic gadgets like GPRS devices which most of the schools didn't have. However, through some training seminars, proficiency have now increased* (Interviewee 2)

What is clear from the above analogue is that, the majority of the respondents professed competence with regards to the use GIS in geography education. This is supported by a study by Šiljeg et al (2022) which focuses on the implementation of GIS in secondary schools, noting that the successful integration of GIS into geography education depends significantly on teachers' understanding, expertise and their ability to use GIS effectively. It discusses the challenges that the teachers face, such as lack of formal education in GIS and the need for additional training to

utilize GIS as a valuable educational tool. Mašterová (2023) also concurs that, prior teacher preparation is essential for effective teaching through inquiry with Geo-Spatial Technologies (GST). This systematic review highlights that teachers need to develop digital competences and knowledge related to (GST) to facilitate student learning effectively.

4.3.3 Data analysis tools

The results of the study indicated that 6.7% % of the respondents strongly agreed that they understood how data analysis tools can be used in geography education were, 10% agree, 66.7% disagree and 16.7% strongly disagree with regards to the use of data analysis tools in geography education. The highest proportion of the respondents 83.4% indicated incompetency while a small percentage of 16.6% understood. The high percentage of participants who indicated lack of understanding in the use of data analysis tools in geography education suggests that there may be a lack of support from the in-service department for teachers in preparing them in these newer technologies. Hence, In-service training and refresher courses were seen as relevant in helping teachers develop the skills and knowledge necessary for the effective use of such technology. One interviewed respondent asserted that:

> *We are expected to utilise these new digital technologies without any meaningful and coordinated additional training or support from the ministry or even at localised levels. It is challenging to make the necessary changes in our teaching practices without adequate professional development opportunities. Sometimes I wonder how and why these things find their way into the curriculum without adequate support* (Interviewee 2)

Another respondent indicated that:

> *I desperately need some professional training on these digital technologies. When I went for my college early 2000, everything was done manually, our teaching has been like that all these years. I feel very much unprepared to even attempt to use these things. To be honest with you, I do not know where and how to make use of these tools you are talking about. We are still depending on the traditional methods that we're used to* (Interviewee 3)

The results generally explained that most of the participants felt unprepared and deskilled in the face of an increased advancement of educational technologies. There seems to be a skills gap between the expectations of the curriculum and what geography teachers know. Good as the curriculum may sound, however, the successful implementation depends on the end user, the teacher (Ndawi & Maravanyika, 2011). Geography education is increasingly becoming digitalised

to an extent that traditional pedagogical practices are being suffocated and becoming irrelevant. This calls for the in-service department in the Ministry of education to address this concern and shortcoming as they have an imperative role to play in the successful adoption of digital technologies in geography education in schools. By providing ongoing professional development and support, in-service education programmes would help teachers overcome challenges and improve their instructional practices (Chandi, 2019).

4.3.4 Educational Chatbots

From the above table it can be noted that most respondents (86.7%) had understanding when it come to the use of educational chatbots. Forty percent (40%) showed an understanding, with a 46% agreeing, another 10% disagree and lastly 3.3% strongly disagree. This concurs with the contribution from one of the respondents who indicated that:

> *Educational chatbots like ChatGPT are easy to use, and does not require much professional training. Most of us we use chatbots because of the accessibility of a wealth of information and resources that allows for personalized learning experiences provide quick responses to questions. They are user-friendly and they provide resources for teaching* (Interviewee 3)

In support to this view, another respondent gave their views and said that,

> *Educational chatbots do not necessarily require that one be trained to use them. As long as I have data on my laptop or cell phone, I can find whatever I want on the go. I feel very comfortable and competent to navigate through, and these have aided us teachers in handing routine questions and administrative tasks, freeing up more time for personalized instruction* (Interviewee 2)

The general response from the respondents revealed that the majority of teachers are relatively at ease when it comes to using educational chatbots since they do not require any specialized training. Various studies in education have confirmed the benefits of chatbots (Karaduman & Yetisensory, 2023). A study by Kim (2018) revealed that the learning performance and attitudes of students were positively affected by chatbots. However, some were skeptical about these new technologies as they feared that overreliance on technology will diminish their critical thinking skills and research kills. Kooli, (2023) posits that, as the students become accustomed to receiving answers quickly their problem solving and critical thinking skills can negatively be affected.

4.4 Views of Geography teachers towards the use of AI in Geography teaching and learning

In this section, the results are presented under the theme geography teachers' views towards the use of AI in geography teaching and learning. Table 4.3 below shows the results from the respondents

Table 4.3: Respondents on the relevance of AI to Geography teaching and learning (n=30)

Attributes	Strongly agree		Agree		Disagree		Strongly Disagree	
	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
AI affords personalised learning	5	16.7	13	43.3	7	23.3	5	16.7
Enables interactive visualisation	12	40	13	43.3	3	10	2	6.7
Motivate learners	14	46.7	9	30.	5	16.7	2	6.7
Facilitates in-depth geographic data analysis	12	40	8	26.7	6	20	4	13.3
AI helps understand abstract phenomena	21	70	6	20	0	0	4	13.3
Provides for assessment and feedback	9	30	12	40	8	26.7	1	3.3
AI affords accessibility of information	24	80	4	13.3	2	6.6	0	0
Support for diverse learning styles	18	60	8	26.7	4	13.3	0	0

4.4.1 AI affords personalised learning

Table 4.2 shows that most participants (60%) agreed that AI allows for personalized learning with a 16% indicating strongly agree, 43.3% agree, 23.3% disagree and 16.7% strongly disagreed. Therefore, the presented statistics reveal that the majority of the geography teachers (60%) agree that AI tools affords personalized learning. This concurs with the following response from one of the respondents who highlighted that:

> *I understand that AI tools can analyse students' learning patterns establishing their strengths and weaknesses at the same time so as to provide customized content and exercises. Although I personally have not yet used these tools, I am in agreement that this adaptive learning approach allows students to engage with material at their own pace and level of understanding hence improving their performance* (Interviewee 3)

The same view was also shared by another respondent who said that:

> *AI tools allows for personalized learning by way of targeted interventions. AI tools can identify specific academic challenges faced by students by evaluating their performances*

> *and behavioral data. This enables teachers to offer targeted support, such as additional practice exercises or personalized tutoring, which helps students overcome difficulties* (Interviewee 4)

Therefore, the general view is that AI tools are useful because they allow for personalized learning, tailor-making content to suit learners and their different educational needs. This concurs with Claned (2024) who acknowledged that AI-powered educational tools allow educators to specifically identify and support students with certain academic difficulties. The evaluation of the student' success and behavioral data by AI systems allows for detecting the areas where the student might face difficulties.

4.4.2 Enables interactive visualisation

The table 4.3 above shows that the participants who strongly agree that AI tools enables interactive visualisation constituted 40%, and those who agree 43.3%, those who disagree were at 10%, then strongly disagree 6.7%. Therefore, the presented statistics reveal that the majority of geography teachers (83.3%) agree that AI tools affords for interactive visualization. This concurs with the following in-depth interview response from one of the respondents who indicated that:

> *What I know is that AI has the capability of analyzing large volumes of data in real-time through algorithms. Although we rarely use this in the classroom because of various reasons that I think you are also familiar with like the absence of internet connectivity at our schools* (Interviewee 3)

Another respondent added that:

> *AI tools allows a user-centric interaction with visualizations. This is can be achieved by learning from user behaviour and preferences consequently AI systems can adapt the visualization interface to better suit individual needs, making it easier for users to explore and understand the data* (Interviewee 4)

These findings therefore revealed that, the participants generally agree that AI tools enables interactive visualisation. This concurs with the Wang et al (2023) who posits that, visualisation can facilitate humans in data understanding through intuitive visual representation and interactive exploration.

4.4.3 AI Motivates students

Table 4.2 shows that 46, 7% strongly agree that AI in geography education helps motivate learners, 30% agree, 16.7 disagree and 6.7% strongly disagree. Therefore, the presented data shows that the majority of participants (76,7%) agree that AI helps in learner motivation. This concurs with a response from a respondent who noted that:

> *Motivation in teaching is very important. Leaners have different learning styles which as a teacher I must take note of for them to remain engaged. Learning can sometimes become monotonous and tedious, so as a teacher I must be very resourceful and leverage on AI tools like Virtual reality and augmented reality so as to retain their interest* (Interviewee 6)

Another respondent highlighted that:

> *Motivation can come from curiosity, a passion for the subject, or external rewards, motivation helps shape how students approach education. Rather than piling up hordes of notes on students, leaners need an interactive environment that keeps them engaged. In these days of social media, they are exposed to vast animations and pictures that carry information. I believe AI has tremendous potential to motivate students in Geography* (Interviewee 5)

Another respondent however expressed some reservations and commented that:

> *While I see the potential for AI to motivate students, I have some reservations. Many of my colleagues and I feel underprepared to use AI effectively in the classroom. The technology can be intimidating, and there are concerns about how it might change our teaching practices. I think it's essential to have a structured training program that not only teaches us how to use AI tools but also addresses the pedagogical implications of using these technologies* (Interviewee 8)

These results therefore resonate with Lambert (2021) who posits that, AI-powered applications, such as virtual reality (VR) and augmented reality (AR), can create immersive learning experiences that engage students in a dynamic way. For example, geography teachers can use VR to take students on virtual field trips to different geographical locations, allowing them to explore and interact with environments that they may not be able to visit in real life. This hands-on approach can significantly enhance student interest and motivation. Mohamed et al (2024) also says that, in AI classes, tools that dynamically display and animate complicated concepts can motivate learners and improve their learning experience.

4.4.4 Facilitates in-depth Geographic data analysis

From Table 4.3 above, it could be seen that most of the respondents (66.7 %) agree with the view that AI facilitates in-depth geographic data analysis. Forty (40%) of the respondents strongly agreed that AI tools facilitates an in-depth geographic data analysis, with another 26.7% agreeing and 20% of the respondents disagree whilst 13% strongly disagree. Therefore, the majority of the participants responded positively to this view. From the in-depth interviews conducted, one of the respondents indicated that:

> *Geographic data is quite extensive that it requires powerful data analysis tools. Artificial Intelligence (AI) significantly enhances in-depth geographic data analysis through various methodologies and applications. AI enables the integration of diverse geospatial datasets, including satellite imagery, GPS data, and social media information. This integration allows for a more comprehensive analysis of geographic phenomena by combining different data sources to create a unified geospatial database* (Interviewee 6)

Another respondent added that:

> *Artificial intelligence (AI) employs advanced analytical techniques, such as machine learning and deep learning, to extract meaningful patterns from complex spatial datasets. These techniques enable the identification of trends and anomalies that traditional methods might overlook. For example, AI can analyse historical geospatial data to forecast future scenarios, such as urban growth or climate change impacts, thereby enhancing predictive modelling capabilities* (Interviewee3)

4.4.5 AI helps understand abstract geographic phenomena

Table 4.3 above shows that the majority of the participants (70%) strongly agree that AI tools help in understanding abstract geographic phenomena, 20% agree, 0% disagree and 1.3% strongly disagree. Therefore, the majority of the respondents 90% agree that AI aids in understanding abstract geographic phenomena. This concurs with one of the respondents who contributed that:

> *My understanding of abstract geographic phenomena is that, these are geographic concepts and patterns in geography that are not directly observable or easily quantified but are essential for understanding spatial relationships and human-environment interactions. These phenomena often involve complex systems usually physical, social dynamics, and theoretical frameworks. So, AI plays a vital role in understanding these abstract phenomena through various techniques, applications and methodologies.* For example, *Spatial Analysis* (Interviewee 4)

Another respondent added that:

> *AI has the capability of bringing unobservable phenomena closer to the student like some wind patterns and underground processes and this makes teaching geography a lot easier*

> *as these can be accessed through various AI tools like augmented and virtual reality* (Interviewee 3)

Therefore, these findings have revealed that the majority of the participants understand how AI can be leveraged to bring abstract geographic phenomena closer to the student. This concurs with Gao (2023) who noted that AI technologies have permitted deeper insights into complex human-environment connections. In support, (Huang et al., 2021) indicated that AI has contributed effectively to scientific exploration, understanding of social dynamics, and spatial decision-making. Geography teaching and learning has been, among many other fields, revolutionised by the advent of technological advancement in recent decades (Zawacki-Richter, 2019).

4.4.6 Provides for assessment and feedback

Table 3 shows that 30% of participants strongly agreed with the view that AI provides for assessment and feedback, 40% agree, 26.7% disagree and 3.3% strongly disagree. The data indicates that 70% of geography teachers perceive AI as a valuable tool for assessment and feedback. However, the 30% who disagree or express scepticism raises important considerations about the adoption of AI in educational contexts. In this regard one of the respondents highlighted that:

> *I believe AI has tremendous potential in providing assessment and feedback in geography education. Having used some AI tools in my classroom, I've seen how they can offer immediate feedback to students, which is incredibly valuable. These tools can analyse student performance in real time, identifying areas where they struggle and suggesting targeted resources. It allows me to focus on individual student needs without being overwhelmed by grading. However, I do think it's essential for us teachers to receive proper training on how to interpret AI-generated data effectively* (Interviewee 6)

However, another respondent indicated that:

> *While I appreciate the advancements in AI and its potential for assessment and feedback, I have significant concerns about its implementation in geography teaching. My experience has shown me that AI tools can sometimes lack the context and depth necessary for effective feedback. For instance, they may not fully consider* (Interviewee 5)

The above concerns are supported by a research by Mook et al (2020) which highlights that while AI assessments can provide scalability and efficiency, they often lack the depth and context of traditional assessment methods. Additionally, studies by Luckin et al (2016) emphasize the importance of teacher involvement in the assessment process to ensure that AI tools complement rather than replace human judgment.

4.4.7 Accessibility of information

Table 3 shows that 80% of the participants strongly agree that AI affords accessibility of information, 13.3% agree, 6.6% disagree. It indicates a unanimous agreement (93.3%) reflecting a strong belief in AI's ability to provide accessible information. The data reveals a striking consensus among geography teachers regarding the role of AI in enhancing accessibility to information. In this regard a respondent indicated that:

> *I am genuinely excited about the role AI plays in making information more accessible for both teachers and students in Geography. With AI tools, students can quickly find a wealth of resources that were previously difficult to obtain, especially for more specialized topics. This immediate access fosters a more engaging learning environment where students can explore their interests in geography more deeply. I feel well-prepared to integrate these tools into my teaching, as I've taken the initiative to learn about various AI platforms and how they can enhance our curriculum* (Interviewee 6)

Another respondent indicated that:

> *While I see the potential of AI in enhancing accessibility to information, I have some reservations. Yes, AI can provide a vast array of resources that can benefit students, particularly those who might struggle with traditional materials. However, I worry that we need to be cautious about how we implement these tools. Many of my colleagues, including myself, feel somewhat unprepared when it comes to integrating AI effectively into our teaching practices* (Interviewee 5)

With 93.3% of respondents either strongly agreeing or agreeing, supporting the notion that technology can bridge gaps in education equity (Zawacki-Richter et al., 2019). This enthusiasm shown by the majority of teachers is supported by research, Luckin et al (2016) indicating that AI can democratize access to educational resources, allowing students to engage with a broader range of materials and perspectives. The apprehension regarding information overload is particularly relevant, as students may struggle to navigate the vast resources available online. This concern is echoed in the literature, which highlights the need for critical digital literacy skills to help students discern credible sources from unreliable ones (Hollands et al., 2020). Additionally, the teacher's call for more training and resources reflects a broader consensus in educational research that emphasizes the necessity of equipping teachers with the skills and knowledge to utilize AI effectively (Kim, 2021). Without adequate preparation, the potential benefits of AI in enhancing accessibility may not be fully realized.

4.4.8 Support for diverse learning styles

Table 4.3 shows that60% of the participants strongly agree that AI tools support diverse learning styles, 26.7% agree and 13.3% disagree. The table also indicate that, none of the participants strongly disagree that AI caters for diverse learning styles. The data regarding support for diverse learning styles among geography teachers shows a favourable inclination towards the use of AI in education. With a total of 86.7% of respondents either strongly agreeing or agreeing and it is evident that a significant majority of geography teachers recognize the importance of accommodating various learning styles through AI tools. Only 13.3% of teachers disagreed, and none strongly disagreed, indicating a general consensus on the positive impact of AI in this area. In support a respondent noted that:

> *I am a strong advocate for using AI to support diverse learning styles in my geography classes. The ability of AI tools to tailor resources to individual student needs is one of its most exciting features. For instance, some students benefit from visual aids, while others may prefer interactive simulations or text-based resources. AI can analyse each student's learning preferences and adapt the content accordingly, making it easier for everyone to engage with the material* (Interviewee 6)

Another respondent highlighted that:

> *While I understand the potential of AI to support diverse learning styles, I have some reservations about its practical implementation. Many of my students have unique needs that require more than just algorithm-driven adjustments. For example, while AI can offer different types of resources, it may lack the human touch needed to truly understand and respond to a student's emotional and educational context* (Interviewee 5)

The results therefore show that the majority of the participants agree that AI caters for the diverse learning styles. The strong agreement reflects an understanding that students learn in different ways and that AI can help tailor educational experiences to meet these diverse needs (Kanchon et al., 2024). This aligns with the notion that using varied instructional methods can enhance student engagement and comprehension. In the same vein, Yli-Panula et al (2019) agrees that AI technologies can analyse individual learning preferences and adapt resources accordingly, providing visual, auditory, and kinaesthetic learning opportunities. This customization is crucial in geography education, where concepts can be complex and multifaceted. Abubacker (2025) concurs and posits that when educators employ strategies that cater to different learning styles, it can lead to improved academic outcomes and greater student satisfaction

4.5 Challenges faced by Geography teachers in integrating AI tools in Geography teaching and learning

Table 4.4 below presents the challenges that geography teachers face when using AI in Geography teaching and learning.

Table 4.4: Challenges encountered when using AI tools in teaching and learning (n=30)

Attributes	Strongly Agree		Agree		Disagree		Strongly Disagree	
	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
Lack of training and CPD	20	66.7	4	13.3	6	20	0	0
Insufficient resources	19	63.3	5	16.7	4	13.3	2	6.7
Curriculum constraints	7	23.3	5	16.7	10	33.3	8	26.7
Resistance to change	16	53.3	4	13.3	3	10	7	23.3
Infrastructural limitations	18	60	6	20	5	16.7	1	3.3

4.5.1 Lack of training and continuous professional development

Table 4.4 shows that a significant 66.7% of teachers strongly agree that a lack of training is a major barrier, 13.3% agree, whilst 20% disagree and 0 % strongly disagree. This indicates a pressing need for professional development programs tailored to AI integration in geography education. This is in line with this one of the respondents indicated that:

> *The lack of training is definitely a significant barrier to using AI in our classrooms. I feel that many of us are not equipped with the necessary skills to integrate these technologies effectively. While I understand the potential of AI to enhance teaching and engage students, I often find myself hesitant to use it because I lack the confidence and know-how* (Interviewee 6)

Another respondent indicated that:

> *I strongly agree that inadequate training is a major obstacle. Although I see the value of AI in making lessons more interactive and personalized, the absence of structured training programs leaves many teachers, including myself, feeling unprepared. We need*

> *comprehensive training that not only familiarizes us with the tools but also provides strategies on how to implement them in our lessons. Without this, it's challenging to motivate students using AI effectively* (Interviewee 7)

Another respondent noted that:

> *Lack of training is a critical issue for the effective use of AI in geography education. Many teachers are resistant to change, and this resistance often stems from not knowing how to use new technologies. If we had more targeted training sessions and ongoing support, I believe we could overcome this barrier. Training should include hands-on experiences and practical examples relevant to our curriculum, which would help build our confidence and willingness to adopt AI in our teaching practices* (Interviewee 2)

These results therefore reveal that effective training is crucial for teachers to feel confident in using new technologies. Without adequate training, teachers may struggle to implement AI tools effectively, which can hinder student engagement and learning outcomes. Mitchell et al (2018) avers that professional development in geography education builds teachers' confidence and competence in using innovative teaching methods. She adds and say when teachers feel prepared, they are more likely to implement new strategies and technologies in their classrooms, leading to improved student engagement and learning outcomes.

4.5.2 Insufficient resources

The table 4.4 shows that over three-quarters of respondents (80%) highlight insufficient resources as a challenge, emphasizing the need for better access to technological tools and materials. The other 20% disagree that lack of resources was not a barrier to AI use in Geography learning. In support one of the respondents added that:

> *Insufficient resources are a major hurdle for us when it comes to integrating AI into geography education. Many of our classrooms lack the necessary technological tools, such as updated computers and reliable internet access. Without these resources, even the best AI programs can't be utilized effectively. I believe that investing in technology is crucial if we want to prepare our students for the future and fully harness the potential of AI in our lessons* (Interviewee 1)

From a different angle a respondent highlighted that:

> *I believe that a lack of resources is not the primary barrier to using AI in geography education. The real challenge lies in how we use the available resources effectively. With*

> *proper professional development and training, teachers can learn to maximize the impact of whatever tools they have. AI can be integrated into lessons using simple platforms that don't require extensive resources. For instance, my mobile phone here can be used to access any relevant tools for teaching* (Interviewee 5)

Another respondent noted that:

> *In my own view, insufficient resources are undoubtedly one of the biggest barriers to using AI effectively in geography education. It's frustrating because many of us recognize the potential of AI to enhance student learning, but without access to the right tools like interactive software and updated hardware it's hard to make that vision a reality. Comprehensive support from the education authorities in terms of funding and resources is essential if we want to see meaningful change in geography teaching* (Interviewee 7)

The results from this theme has shown that, the majority of the participants (80%) pointed to lack insufficient resources as a hindrance to the effective use of AI in geography teaching. However, others had different views. Twenty (20%) of the participants had other views instead. Their views are supported by Gubevu, & Mncube (2024) who are of the view that, mobile smartphones can serve as powerful tools for integrating AI into geography lessons. Teachers can leverage these devices to access various AI applications and resources, enabling them to enhance their teaching without needing extensive technological infrastructure. For example, students can use mobile devices to engage with geographic information systems (GIS) and other AI-driven tools that facilitate interactive learning experiences (Keengwe et al 2014). Philip and Garcia, (2013) observed that teachers are increasingly employing innovative pedagogical strategies that do not rely heavily on advanced technology. For instance, Montalvo (2024) suggests that, project-based learning and inquiry-based approaches can incorporate AI concepts through accessible platforms and applications, allowing students to explore geographic topics in depth without requiring extensive resources.

4.5.3 Curriculum constraints

Table 4.4 shows that 23.3% of the participants strongly agree that curriculum constraints were a barrier to AI use in geography teaching, another 16, 7% agreeing to this view, 33.3% disagreeing whilst 26.7% strongly disagree. The results indicate that the majority of the participants (60%) disagree that curriculum constraints was a hindrance to AI use. Responses from in-depth

interviews reveals mixed views from participants with regards to curriculum constrictions on AI use in geography teaching. From the in-depth interviews one respondents reported that:

> *Curriculum constraints are often viewed as limiting, but I see them as an opportunity to innovate. AI can actually enhance the engagement of students within the prescribed curriculum. By using AI-driven simulations or interactive mapping tools, I can make traditional geography topics more dynamic and relevant. This way, I'm not deviating from the curriculum; I'm enhancing it* (Interviewee 6)

However, another respondent indicated that:

> *Curriculum constraints definitely pose a significant barrier to the use of AI in geography teaching. Many educational frameworks are rigid and do not allow for much flexibility in how we deliver lessons. This rigidity makes it challenging to incorporate innovative AI tools that could enhance student learning. We often find ourselves sticking strictly to the curriculum, which limits our ability to explore new technologies and teaching methods that could engage students in more meaningful ways* (Interviewee 2)

Another respondent added that:

> *Curriculum constraints are a major hurdle when it comes to integrating AI into geography education. The pressure to cover a vast amount of content within a limited timeframe means that we often prioritize traditional teaching methods. Thirty-five minutes of lesson tine is not enough. This focus on content coverage leaves little room for experimenting with AI tools. I believe that to effectively incorporate AI, we would need to rethink our curriculum structure, but with so many required topics to cover, that simply isn't feasible right now* (Interviewee 3)

The results on this theme indicated that, while some participants conceive the curriculum as rigid and inflexible to the rapid changes being ushered by technological advancement, some have conceptualised it as an opportunity to innovate and enhance it. Notwithstanding the opportunities that AI affords in education, curriculum rigidity has been pointed as a barrier to the full realisation the potential of AI (Lin & Chen, 2024). Research indicates that many educational curricula are often rigid, with strict guidelines on content coverage and assessment methods for example (Gao, 2021) posits that the rigidity of educational frameworks limits teachers' ability to incorporate innovative technologies like AI, which require flexibility to adapt lessons and explore new teaching approaches. Southworth et al (2023) argued that the lack of adaptability in curricula can stifle creativity and hinder the integration of AI tools that could enhance learning experiences. Kaya (2018) also noted that that geography teachers often face significant time pressures to cover extensive content within a limited timeframe.

4.5.4 Resistance to change

Table 4.3 shows that most respondents, either strongly agree or agree that resistance to change was a barrier to AI use in geography teaching, with 60% strongly agreeing, 20% agreeing, whereas 16.7% disagree and 3.3% strongly disagreeing. The results show the large proportion of the participants (80%) viewed resistance to change as hindrance to artificial intelligence use in geography teaching against a 20% that disagreed. One respondent said that:

> *What I personally think causes resistance to change is the aspect of scepticism that some teachers have regarding the use of AI in teaching geography. Many teachers question whether AI can truly enhance learning outcomes or if it complicates the teaching process. This hesitation can lead to a reluctance to experiment with AI tools, as they may feel more comfortable relying on traditional methods that they believe have proven successful over the years. This mindset creates a barrier to embracing new technologies that could ultimately improve student engagement and understanding* (Interviewee 4)

Another respondent added that:

> *It is true that resistance to change is a significant barrier to the integration of AI in geography teaching. Many teachers are accustomed to traditional teaching methods and may be hesitant to adopt new technologies. We Geography teachers continue to conduct our lessons using textbook pedagogy instead of using digital resources that we should use. This cultural resistance can stem from a lack of familiarity with AI tools or a fear of disrupting established practices. Even when AI could enhance learning experiences, some teachers may prefer sticking to what they know, but this stifles innovation and limits the potential benefits of AI in the classroom* (Interviewee 8)

However, on the contrary, some did not consider it as a barrier to AI use in geography teaching. One respondent reported that:

> *I believe that resistance to change is often overstated when it comes to integrating AI in geography teaching. Resistance to change isn't necessarily a barrier to using AI in geography education if anything, students often drive the change. As digital natives, students are generally enthusiastic about using technology, including AI tools. This enthusiasm can influence teachers to adopt these innovations, as they see their students engaged and excited about learning. In my experience, when teachers witness the positive impact of AI on student learning, it encourages them to embrace change rather than resist it* (Interviewee 6)

The results generally indicated that the successful adoption of AI in geography teaching is being met by resistance to change. There are several reasons why change is resisted. Respondents cited incompetence and lack of familiarity with the new technologies. This concurs with Banerjee et al (2022) who say that, effective integration of AI in geography education requires ongoing professional development. Geography teachers need to be exposed to not only the technologies proper, but also must understand how to utilise them. Langreo (2024) posits that, when teachers are not provided with adequate training or resources to understand and implement AI tools, they may feel unprepared and hesitant to incorporate these technologies into their teaching. Teachers express scepticism about the effectiveness of AI in enhancing learning outcomes. This scepticism according to Park et al (2024) can lead to a reluctance to experiment with AI tools, as teachers may prefer to rely on traditional methods that they believe have proven successful.

4.5.5 Infrastructural limitations

Table 4.4 shows that, 60% of the participants strongly agree that infrastructural limitations hinders the use of AI in geography teaching, with 20% agreeing, 16.7% disagreeing and 3.3% strongly disagreeing. In the same vein a respondent indicated that:

> *I see infrastructural limitations as a significant barrier to effectively integrating AI into geography teaching. Many schools, including mine, struggle with outdated technology and insufficient internet access, which hampers our ability to utilize AI tools fully. Even when I'm enthusiastic about using innovative resources, I often find that the necessary infrastructure isn't in place to support them. For example, if students can't access reliable internet or the latest devices, they're unable to engage with AI-driven learning experiences that could enhance their understanding of geographical concepts* (Interviewee 3)

Another respondent said that:

> *While I acknowledge that infrastructural limitations pose challenges to using AI in geography education, I'm optimistic about the potential for improvement. Yes, many schools face issues like inadequate technology and connectivity, which can limit AI integration. However, I believe that with the increasing emphasis on digital learning, there is a growing recognition of the need for investment in educational technology* (Interviewee 1)

From the above results it can be noted that, the majority of the participants (86.7%) cited infrastructural limitations as a barrier to AI usage in geography teaching and learning. Data gathered from the interviews shows an acute infrastructure gap and this has attributed significantly

to the lack of AI usage in geography teaching and learning. Several studies have also revealed the same constraints, for example a study by Bernhäuserová et al (2022) showed that infrastructural constraints were a major barrier as many schools lack the necessary technology to effectively teach GIS, which includes both physical devices and the software required for instruction. The lack of basic infrastructure like electricity was also cited as a major barrier due to incessant power cuts being currently experienced in the country. Gora (2022) cited that, the lack of electricity disrupts access to online resources and databases necessary for research, further hindering academic performance.

4.6 Possible solutions to the challenges of AI integration in Geography teaching and learning.

In this section, the results are presented under the theme, possible solutions to the challenges faced by geography teachers in AI integration. Table 4.5 below outlines the solutions and the responses from those who participated in the interviews.

Table 4.5: Respondents' opinions on possible solutions (n=30)

Attributes	**Strongly Agree**		**Agree**		**Disagree**		**Strongly Disagree**	
	(n)	**%**	**(n)**	**(%)**	**(n)**	**(%)**	**(n)**	**(%)**
In-service training	15	50	9	30	5	16.7	1	3.3
Online courses	18	60	6	20	4	13,3	2	6.6
Peer mentoring	9	30	10	33.3	5	16.7	2	6.6

Curriculum development involvement	19	63.3	7	23.3	3	10	1	3.3

4.6.1 In-service training

Table 4.5 shows that half of the participants (50%) strongly agree that in-service training was a possible solution to solving the challenges faced by teachers in AI integration. A further 30% agree, 16.7% disagree and 3.3% strongly disagree. The results indicate that in-service training was viewed as important to close a skills gap that exits. The lack of in-service training for geography teachers was seen as a cause of a mismatch between expected outcomes and the actual practices obtaining. One of the respondents indicated that:

> *In-service training is crucial for geography teachers, especially when it comes to integrating AI into our teaching methods. Many of us didn't have formal training in technology or AI during our initial education. Continuous professional development helps us stay current with emerging tools and methodologies. Without this training, we risk falling behind in our teaching practices and not fully engaging our students. In Chitungwiza, in-service training can provide the necessary skills and confidence to incorporate AI effectively into geography education* (Interviewee 1)

Another respondent added that:

> *I believe in-service training is key to bridging the knowledge gap that many geography teachers face regarding AI. While some of us may have a basic understanding of AI, we often lack the specific strategies to apply it in our classrooms. In-service training sessions can offer tailored workshops that address our unique challenges and needs* (Interviewee 2)

The bigger proportion of respondents indicated that in-service training programs like seminars and workshops were crucial to upskill geography teachers and close the skills gap that exist. There're some respondents who mentioned that students of this generation have more ties with the digital world, and as such teachers are supposed to upskill in order to match with the 'born digital' generation. This concurs with Yıldırım and Ünlü (2021) who said that in-service training must be tailored to meet the demands of this generation and the needs of the teachers. Professional development opportunities that focus on the principles and practices of differentiated instruction can help teachers develop the skills and confidence needed to effectively tailor instruction to the diverse needs of their students. Koç (2013) observed that developments in different areas of the geography discipline require a transformation of teachers' knowledge, attitudes, and behaviours.

These developments amplify the importance of in-service courses and shape the content of field trainings of different disciplines. Meydan & Uzunöz (2017) agrees that Geography teachers must therefore constantly undertake professional development courses to remain relevant in this fast-changing world of technology.

4.6.2 Online courses

The results obtained from in-depth interviews shows that, 60% of the participants strongly agree that On-line training course were beneficial or important in solving the challenges faced by the geography teachers, 20% agree, 33.3% disagree and 3.3% strongly disagree. Online courses, though not common option for geography teachers, they still believe that if afforded the opportunity, such programs would help in improving proficiency among geography teachers. A substantial 60% report never participating, and only 10% do so sometimes. This indicates a significant barrier to accessing online training and highlights the need for better infrastructure or motivation to utilize these resources. A respondent expressed the following sentiments:

> *Online programs present a significant opportunity for geography teachers facing challenges in integrating AI into their teaching practices. One of the main advantages is the flexibility they offer. We can access a wide range of resources and training modules at their own pace, which allows us to become familiar with AI tools without the pressure of a traditional classroom setting.* (Interviewee 5)

Another respondent further alluded that:

> *One of the key benefits is the ability to connect with a community of educators who are facing similar challenges. Through forums, webinars, and collaborative projects, teachers can share best practices, troubleshoot issues, and learn from each other's experiences*. (Interviewee 2)

On the other hand, another participant responded that

> *While online programs can provide valuable resources, they often fall short in addressing the specific challenges geography teachers face in integrating AI. One major issue is the lack of hands-on, practical experience that in-person training offers. Geography often requires experiential learning fieldwork, local studies, and interactive mapping that online programs struggle to replicate.* (Inteviwee8).

Furthermore, the results indicate a mixed opinion on On-line courses or programs as a possible solution to the challenges of AI integration in geography education. The majority of the respondents (80%) showed a positive attitude towards this training method, with only 20% disagreeing. Whereas some participants viewed it as beneficial, others however were somewhat sceptical on its applicability and usefulness. They cited an array of reasons and challenges of this method of training. Chief among these challenges is that online training often lacks the interactive components that are present in face-to-face training (Palmentieri, 2022). This can result in a less engaging learning environment, making it difficult for teachers to connect with peers and instructors. The absence of real-time discussions can diminish the collaborative learning experience that is vital for professional development. Teachers may struggle to find the time to complete coursework amidst their other responsibilities, leading to incomplete training and a lack of preparedness to implement new strategies in their teaching (Wuam & Bulus, 2022).

4.6.3 Peer mentoring

The results indicate that 30% of the participants strongly agreed that peer mentoring affords a solution to challenges of AI integration in geography education, 33.3% agree, 16.6% disagree and 6.6% strongly disagree. These results show that peer mentoring appears to be relatively well-received among geography teachers, with a combined 63.3% reporting that they agree. This suggests that many teachers find value in collaboration with their peers, indicating a positive culture of support and shared learning in their professional environment. In this regard, a respondent acknowledged that:

> *Peer mentoring has been invaluable for me as a geography teacher. In Chitungwiza, we often face similar challenges, especially when it comes to integrating new technologies like AI into our lessons. Having a peer mentor means I can discuss my ideas, get feedback, and learn from their experiences. This collaborative approach helps us feel more confident and prepared to use AI tools effectively in the classroom. It's a support system that not only enhances our individual skills but also strengthens our teaching community* (Interviewee1)

Another respondent said that:

> *I believe that peer mentoring is essential for geography teachers, particularly as we navigate the complexities of AI in education. When we mentor each other, we share practical strategies and resources that can demystify the technology. For instance, one of my colleagues introduced me to an AI tool that helps with data visualization, and through our mentoring sessions, I learned how to incorporate it into my lessons. This not only boosts my confidence but also prepares me better for teaching geography in a tech-savvy way* (Interviewee 7)

These findings show that the participants were open minded and saw peer mentoring as an important tool for professional development throughout the entire teaching career with regards to AI in geography teaching. Mentoring is necessary especially for Geography teachers in their initial stages. Smith (2022) agrees that, school mentors play a key role in beginning teachers' professional development. Peer mentoring serves as a form of professional development, where teachers can learn from one another's experiences. Carragher and McGaughey (2016) observed that this continuous learning environment encourages teachers to stay updated with the latest trends and methodologies in geography education, which is crucial in a rapidly changing educational landscape.

4.6.4 Curriculum development workshops

Curriculum development workshops are highly valued by the participants with 86.6% of teachers agreeing that they provide a solution to the challenges of AI use in geography education. The low percentage 13.3% either disagree or strongly disagree that that curriculum development workshops can be a solution to the challenges of AI use in geography education. A respondent advanced that:

> *Curriculum development workshops have been crucial for my preparedness to use AI in my geography classes. These workshops provide a structured environment where we can explore new teaching methods and technologies together. Recently, I attended a workshop focused on integrating AI tools into our geography curriculum. It was enlightening to collaborate with colleagues, brainstorm ideas, and discuss how to align AI with our learning objectives. I feel much more equipped to implement these tools effectively in my teaching now* (Interviewee 1)

Another respondent lamented that:

> *As stakeholders in the curriculum development process, I think we as geography teachers our contributions are very crucial since we are the end users of these packages.*

> *Unfortunately, much of what we contribute doesn't make it into the final product. AI technologies are new to us which I believe the CDU should be circumspect detailing how it should be used in geography education* (Interviewee 4)

The results therefore highlight the significance of geography teachers' participation in the curriculum development. Geography teachers are best placed to understand the best practices and dynamics involved in the use of educational technologies. Qing-li et al (2024) agrees that Geography teachers can contribute to the design and planning of the curriculum by providing insights into what geographical knowledge and skills are essential for students. They help articulate the curriculum's intent, which includes defining the goals and objectives of geography education. Ontong and Le Grange (2018) observes that this involvement ensures that the curriculum reflects current geographical issues and methodologies, making it more relevant to students' lives especially in this fast-moving world of technology. Lambert (2021) in the same vein asserts that, Geography teachers are often at the forefront of integrating innovative teaching practices and technologies into the curriculum. Bodzin et al (2016) says that the teachers' involvement in curriculum development allows them to advocate for the inclusion of new tools, such as GIS and AI, which can enhance students' learning experiences and engagement.

4.7 Chapter summary

This chapter analysed and interpreted the qualitative and quantitative results in order to respond to the research objectives espoused in chapter 1. The chapter was grounded in quantitative and qualitative analysis in its interrogation of themes around the following research objectives: knowledge and skills of geography teachers, teachers' views towards AI tools, and barriers for AI use in geography teaching, training needs and professional development for geography teachers. Scholarly views were included in the interpretation of the results, in order to create the platform

for comparative analysis. The next chapter will summarise the project, draw conclusions and outline the research recommendations.

CHAPTER 5: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter provides a summary of the project, answers to the main research objective, recommendations and areas for further study.

5.2 Summary of the project

Chapter 1 of the research presented the definition of the problem, background of the study, statement of the problem, research questions, assumptions of the study, significance of the study, delimitation of the study, limitations, definition of key terms, and the chapters' layout. The research sought to evaluate the level of preparedness of geography teacher in Artificial intelligence in the teaching of geography in Chitungwiza. Chapter 2 looked at literature review which provided literature on Artificial intelligence use in geography teaching. The chapter presented the TPACK theory and the TAM theory as the guiding frameworks for the study. The chapter looked at the geography teachers' level of AI knowledge and skills proficiencies with AI tools, the views of geography teachers towards AI tools, challenges faced by geography teachers in AI use and then possible training needs and professional development opportunities. Chapter 3 presented the research design, methods/tools, population, sample and sampling procedure, data analysis, research integrity and ethical considerations. The research was grounded upon a pragmatist paradigm. The pragmatists' paradigm is rooted in the philosophy that knowledge and reality are a product of beliefs and habits that are socially constructed. In chapter 4, the researcher looked at data presentation, analysis and discussion. The chapter analysed and interpreted results concerning the issues under investigation. The study revealed several key findings regarding the preparedness of geography teachers for utilizing AI in their teaching practices. The following were the major results:

- Many teachers reported a lack of familiarity with AI technologies and their applications in geography education. While some teachers had heard of AI, few had engaged with specific tools or understood their potential benefits.
- The data indicated a strong desire among teachers for professional development opportunities focused on AI integration. Workshops and training sessions were identified as critical for enhancing their skills and confidence in using AI tools effectively.
- Teachers expressed concerns about the unavailability of resources, including access to technology and training. Additionally, some teachers noted a lack of institutional support for integrating AI into the curriculum, which hindered their preparedness.
- Possible solutions to the challenges faced by geography teachers included in-service training of teachers for them to keep pace with the rapidly evolving digital world.

5.3 Conclusion

While teachers had a clear understanding of the relevance of AI to teaching and learning activities, they were inadequately prepared to use it in Geography teaching and learning activities.

5.4 Recommendations.

The results of this study have several recommendations:

- There should be regular training sessions and workshops to improve teachers' understanding of AI tools. These should cover the basics of AI, its applications in
- Encourage teachers to integrate AI tools into their lesson plans by providing examples of effective practices and case studies demonstrating successful applications in Geography.
- Establish a dedicated technical support team to assist teachers with troubleshooting and optimizing the use of AI tools in their classrooms.

5.5 Areas for further study

Future research should explore the following areas:

- Conducting longitudinal studies to track the impact of professional development on teachers' preparedness and student outcomes in geography education.
- The strategies that can be used to prepare teachers in the use of AI in teaching and learning

5.6 Chapter summary

This chapter discussed the results of the study in connection with the findings from related literature, in order to respond to the objectives espoused in the current study. The chapter also included conclusions and recommendations of the study. The conclusions highlighted the results of data analysis and recommendations suggested the way forward. Areas for further study were also suggested.

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APPENDICES

Appendix 1: Introductory letter from the University

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

CEMS DEPT

BINDURA UNIVERSITY OF SCIENCE EDUCATION

Date: 17/09/24

TO WHOM IT MAY CONCERN

NAME: CHIPETURE LUKE. L REGISTRATION: B226415A

PROGRAMME: MscEdGg PART: 1:2

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

The student has to undertake research and thereafter present a Research Project in partial fulfilment of the: Master of Science Education Degree (MscEdGg) programme The research topic is: *An evaluation of geography teachers' preparedness on the use of Artificial Intelligence (AI) tools in the teaching and learning of secondary school geography in Chitungwiza.*

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

Your co-operation and assistance is greatly appreciated.

Thank you

(PHD) Y. Mudavanhu

CHAIRPERSON - CEMS

MINISTRY OF EDUCATION
P.O. BOX CZA 59, CHITUNGWIZA
TEL. 0270-21390 : 04-2906978

MINISTRY OF PRI. & SEC. EDUCATION
CHITUNGWIZA DISTRICT OFFICE
DISTRICT ACCOUNTANT
P.O. BOX CZA 59 CHITUNGWIZA

Appendix 2: Questionnaire for the selected respondents

I am a final year student enrolling for the Master of Science Education (Geography) degree at Bindura University of Science Education. I am carrying a study on *"An evaluation of geography teachers' preparedness on the use of AI tools in the teaching of secondary school geography in Chitungwiza".*

Instructions

You are requested to kindly answer all questions. Please do not discuss with anyone, but answer all questions honestly and truthfully. Carefully read each question, and where you do not understand, do not hesitate to seek clarity and assistance from the researcher. Please insert a tick in the column that indicate your best choice, and if you decide to change your initial response, insert and 'X' on your obsolete choice, and put a tick on your new choice. For confidentiality purposes, please do not endorse your name, initials or signature in any part of this questionnaire.

Section A: Personal information

1. Sex [ ] Female [ ] Male
2. What is your age range in years? Below 30 [ ] 30-40 [ ] 40-50 [ ] 50-60 [ ] 60 [ ]
3. Professional qualifications [ ] DipEd [ ] BEd [ ] MA/ MEd PhD [ ]
4. Teaching experience (years) [ ] Below 5 [ ] 6-10 [ ] 11-15 [ ]16-20 [ ]Above 20

Section B

5. To what extent do you agree that the following opinions on your conceptualisations of the AI.

Attributes	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
AI based lesson planning tools				
Geographic Information Systems				
Data analysis tools				
Educational chatbots				

Section C

6. To what extent do you agree that the following views on the use of AI in Geography learning.

Attributes	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
AI affords personalised learning				
Enables interactive visualisation				
Motivate learners				
Facilitates in-depth geographic data analysis				
AI helps understand abstract phenomena				
Provides for assessment and feedback				
AI affords accessibility of information				
Support for diverse learning styles				

Section D

7 To what extent do you agree that the following opinions on challenges encountered when using AI tools in teaching and learning.

Attributes	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
Lack of training and CPD				
Insufficient resources				
Curriculum constraints				
Resistance to change				
Infrastructural limitations				

Section E

8 To what extent do you agree that the following views concerning training needs for Geography teachers.

Attributes	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
In-service training				
Online courses				
Peer mentoring				
Curriculum development workshops				

Thank you

Appendix 3: Interview guide for the selected respondents

Thank you for agreeing to be interviewed. This study focuses on: use of AI in Geography learning. I believe you can make a significant contribution to gaining insight into the issue under investigation. I am going to ask you some questions which you are free to elaborate on, in ways you consider fit. In case you do not feel like answering the question, you are at liberty to say so. I would like to let you know from the start that your personal and school details will not be included in the final report.

1. Briefly tell me about yourself (with specific reference to professional qualifications, and teaching experience in general).
2. In brief what's your understanding of AI? (Contextualize it to Geography learning activities; Give examples of some of the AI is used in learning activities)
3. How are teachers using these AIs in Geography learning activities? (Give examples where teachers use these AIs in Geography learning activities)
4. What are some of the challenges that you face when using these AIs in Geography learning activities?
5. What possible remedies do you advance in order to address the encountered challenges? (Give special attention to addressing training needs)
6. Thank you for your time and insights.