BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE EDUCATION

EFFECT OF GEOGRAPHICAL INFORMATION SYSTEM AND DIGITAL MAPPING TOOLS ON O-LEVEL MAP WORK PERFORMANCE. A CASE STUDY OF GREAT STRIDE COLLEGE, HARARE.

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YEAR 2025

APPROVAL FORM

SUPERVISOR

I certify that I have supervised **Gambiza Kuziva Energy** (B1544341) for the research entitled, '**Effect of Geographical Information System and digital mapping tools on O level map-work performance. A case study of Great Stride College, Harare'**. In partial fulfillment of the requirements of the Bachelor of Science Education Honors Degree (HBScEd) and recommend that it be examined.

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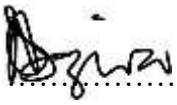
Signature  Date 28 July 2025

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Dedication

I dedicate this art of work to my mom and my loving sister, Thelma, who has been a pillar of strength in every way. Thank you very much for your unwavering love and support.

Acknowledgement

I want express my profound gratitude and special thanks to my project supervisor, **Doctor Daimond Dziva**. His commitment, support and guidance were invaluable during the preparation of this research project. It was through the effort of my supervisor who devoted his time to make possible for this document to be put together. Without his experience, dedication and sacrifice, this study may not have been successful.

I would also like to extend my thanks to school management of Great Stride College for accepting my request to conduct research at their school. My special thanks go to all the respondents who participated freely in this study. My appreciation also goes to my friend Tsaurai Tryphine who assisted me tirelessly with internet data and stood by me during the difficult times of this research.

I also want to express my sincere gratitude to all geography teachers at Great Stride College for their cooperation during data collection period of my research. To the rest of Bindura University students, I have thoroughly enjoyed getting to know you, laugh with you, and work with you – you're my new gold standard for a healthy work environment. Madzudzo Milcent, Takudzwa Mutambara and Tapiwa Chabaya, you have been so helpful and kind, thank you for the random but often funny and educational discussions.

Finally, I would also like to extent my special thanks and heartiest gratitude to the almighty God for guiding me through my academic progression up to this point. If it was not the grace and glory of the lord, my efforts could have been trembled into dust. In a nutshell, I say thank you for the countless blessings.

Abstract

This study investigated the impact of Geographical Information System (GIS) and digital mapping tools on O level learner's performance in map work at Great Stride College, Harare. It addressed the growing need for technological integration in geography education. Employing a mixed-methods research design, the study collected both qualitative and quantitative data through questionnaires administered to 15 O level students and semi-structured interviews conducted with 4 geography teachers. The research aimed to assess the practical utility of GIS tools in developing learner's ability to apply geographical concepts, analyse infrastructural and curricular challenges in GIS implementation, and examine the relationship between GIS proficiency and map work assessment performance. Data analysis, conducted using Microsoft Excel, generated visual representations including tables, pie charts and bar graphs to identify patterns and relationships. The findings revealed infrastructure and resource deficiencies at Great Stride College, with limited access to digital mapping tools effective implementation of technology-enhanced geography instruction. Statistical analysis demonstrated a positive correlation between students GIS proficiency and their performance in map work assessments, with students who received GIS-integrated instruction showing an improvement in spatial analysis tasks compared to traditional methods. Based on these findings, the study recommends that school administrators prioritize investment in digital mapping infrastructure, curriculum developers integrate GIS components systematically into the O level geography syllabus, and teachers receive specialized training in digital geography tools. This research contributes to the growing body of knowledge on educational technology integration in secondary geography education and provides practical insights for improving spatial literacy among O level learners in Zimbabwe.

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ACRONYMS

ArcGIS	Geographic Information System software developed by Esri
BUSE	Bindura University of Science Education
CDTS	Curriculum Development and Technical services
ELT	Experimental Learning Theory
GIS	Geographical Information System
Nvivo	Qualitative Data Analysis Software
QGIS	Quantum Geographic Information System
SCL	Student Centred Learning
STEM	Science Technology Engineering Mathematics

CHAPTER ONE

INTRODUCTION

1.0 Chapter Introduction

This chapter provides an overview of the foundational elements of the study, focusing on the integration of Geographical Information System (GIS) and related digital tools in geography education for O level learners at Great Stride College. It begins by exploring the background of the study, statement of the problem, research questions, research objectives, significance of the study, limitations of the study and definition of key terms and summary of the chapter. Through an examination of these elements, this chapter establishes a framework for understanding the application of GIS and digital tools in the enhancement of O level geography education. The subsequent sections explore these aspects in detail, beginning with an overview of the study's background.

1.1 Background of the study

The transformative potential of Geographical Information System (GIS) and digital tools in education was evident in their ability to shift traditional learning paradigms towards interactive experiences. In today's fast-paced technology-laden world, they could not have placed more emphasis on the importance of being able to access and interpret geographical information (Colic, 2020). This study was concerned with the impact of GIS and digital tools on learners' map work skills in an O level learning, to identify how technology could live and breathe in a

space merging ‘traditionally taught activities in a new idiosyncratic manner to reflect the current technological state of the world’ and the reality of the 21st century. GIS and digital tools have become more prevalent in education in recent years, particularly in the instruction of geography. The technology enables learners to visually assess and analyse spatial data, build understandings of geography concepts, and apply processes related to map work (Harley & Weber, 2018). O level learners would use tools to support them with understanding how to interpret a map in their curriculum. Research shows that students using GIS tools are more likely to express improved abstract spatial thinking and problem-solving skills that can contribute positively to their overall success in map work, Colic (2020). Adding tenets of geographical information systems to demonstrate mapped learning outcomes align with several constructs in education including critical thinking, spatial awareness, engagement with the use of technology and more, including aiding learners towards STEM careers and 21st-century competencies Baker, (2019).. This study also considers several theoretical frameworks with which GIS were embedded in education; such as constructivist learning and experimental learning theories. These theoretical frameworks aim at not only showing how these tools might improve map work skills but also and improved educational goals overall.

However, despite these advantages, there are barriers to the use of GIS and digital tools in education, particularly in Zimbabwe secondary schools. For example, at Great Stride College, many learners only have minimal GIS knowledge, and there were often inadequate training to ensure educators are cognisant of their use in an educational context, and issues related to data interpretation, Sui, Elwood, & Goodchild (2013). Also, inequality in technology access often inhibits equitable use of technologies, especially in lower economy settings, such as rural contexts, Zhang, (2020). Furthermore, resistance to new technologies persists in schools; for

example, students at Great Stride College may favour traditional map work techniques, and be less willing to use GIS, which can limit their willingness to learn. The purpose of this research was to investigate the relationship between technology use and student performance, to identify best practices for incorporating GIS-based education into Geography education, and to explore the issues faced when learners are not able to effectively utilise GIS and digital technology in their studies.

1.2 Statement of the problem

While Geographic Information Systems (GIS) are gaining momentum and receiving attention, the effective integration of GIS into the O level Geography curriculum at Great Stride College in Harare remains a significant challenge. In Zimbabwean secondary schools, only 35% of students feel confident using digital tools for geographical learning, with approximately 65% lacking any confidence, (Chigwamba, 2019). This lack of confidence in students was a concern, especially when considering the current trend to promote technology in education which aims to enhance learning and outcomes.

This situation at Great Stride College was compounded by several significant problems. Many learners lack familiarity with GIS applications which affect their ability to engage with map work-related questions, (Chigwamba, 2019). The same applies in an economically and spatially urbanising world as Harare, spatial awareness and geographical literacy are crucial to understanding our local and global worlds. There was also insufficient training of educators in terms of how to employ GIS into their teaching, (Mwamwenda, 2019). Even if training was available, many teachers, unfortunately, do not possess the required skills to bring digital tools into the classroom with (Victoria, 2020). This means that teachers and learner would necessarily

resort to traditional pedagogy. While such pedagogy was not entirely ineffective, it cannot compensate learners for the neglect of GIS applications and related digital tools. This failure to utilize GIS and applications in Geography education potentially leaves learners underprepared to in any assessment scenario that requires critical analysis and spatial awareness. Furthermore, accessibility to technology was a significant barrier to learning and providing equitable learning opportunities, and technology access impacts about 65% of students from various socio-economic backgrounds itself. This methodological disparity allows inequitable access to technological advancement to equally impact individual learners, which also means an institutional and community-wide effect, (Dewy, 2019). The likely interpretation of the study includes three important areas or challenges: familiarity with GIS among learners, a lack of training for educators related to GIS and a lack of access to technology at the college in general. The research would present and provide important and pertinent areas of consideration to integrate GIS and digital tools into Geography education and to improve geography learning for O level learners.

1.3 Objectives of the study

This study was guided by the following objectives:

1.3.1. To assess the practical utility of GIS and digital tools in developing O level learner's ability to apply geographic concepts and solve map work based problems at Great Stride College

1.3.2. To analyse the curricular and infrastructural challenges faced by O level learners in utilizing GIS and related digital tools for map work tasks at Great Stride College.

1.3.3. To examine the relationship between learners proficiency in using GIS tools and their performance in map work related assessments, identifying key factors that contribute to successful outcomes at Great stride College.

1.4 Research questions

This study was guided by the following research questions:

1.4.1. How does GIS and related digital mapping tools enhance O level learners spatial literacy and map interpretation at Great Stride College?

1.4.2. What are the primary curricular and infrastructural challenges hinder O level learner's effective use of GIS and digital mapping tools for map work tasks at Great Stride College?

1.4.3. What is the current level of integration of GIS and related digital mapping tools into the curriculum at Great Stride College?

1.5 Assumptions of the study

It could be assumed that respondents would answer survey questions honestly and to the best of their abilities. It could also be assumed that external factors such as political instability and natural disasters would not significantly disrupt the study. Also, it could be assumed that external variables for example weather disruptions and school holidays would minimally impact data collection. These assumptions are necessary because without it, the study would need to include additional interventions to train participants, which is beyond the scope of this research. It was

assumed that most O level learners at Great Stride College have had some exposure to digital tools, enabling them to engage with GIS applications during the study period. Variations in individual skill levels are acknowledged but are not expected to significantly affect overall participation. It was also assumed that educators at Great Stride College have received at least minimal exposure to GIS and related digital tools, allowing them to attempt integration into their teaching practices during the study period. Gaps in training would be noted and considered in the interpretation of results.

1.6 Significance of the study

The effect of GIS and digital tools in O level learners in answering map work related questions was definitely an aspect worth examining. The importance of this study emerges from the fact that if the effect of GIS and digital tools are revealed the project would provide basis for solutions to these challenges. The project would also provide insights on how to achieve better results and to give specific actions to be taken to efficiently and effectively address the challenges faced by learners in using GIS and digital tools in answering map work questions.

This study should be of utility value to classroom practitioners, school managers, policy makers, curriculum developers as well as learners. This study would help teachers to identify benefits they can drive from integrating GIS and digital tools in teaching and learning of map work at O level. The researcher submits that that the majority of classroom practitioners are teaching the topic “map work” using lecture method without according learners a chance to use digital tools to practically show the concept. This study would unveil both benefits and challenges of using GIS and digital tools in teaching and learning map work and give

teachers recommendations on how to motivate their learners and increase the use of GIS and digital mapping tools in tackling practical topics like map work.

In addition, the findings of this study concede that this study might be of great importance to the learners. Since the integration of GIS and digital tools in answering map work questions targets to reap positive results, the researcher submits that this study might help learners to enjoy the numerous merits of incorporating GIS and digital tools in answering map work tasks at Great Stride College. Again, the study might also help learners to benefit from mechanisms that would be enforced by teachers, schools heads, policy makers and curriculum developers in a bid to improve the integration of GIS and digital tools in the teaching and learning environment in the secondary schools.

Furthermore, the findings of this study might of great importance to policy makers and those authorities at the helm of developing curriculum. Thus, this study hopes to familiarize officials from Curriculum Development and Technical Services (CDTS) with cultural and physical differences in Zimbabwean secondary schools, calling them for curricula that suit learners from various backgrounds. This study would also help policy makers to recommend the integration of GIS and digital tools in map work teaching with the knowledge of their benefits, short falls that may militate on their effective implementation, as well as possible measures that can be put in place to avert the problems. This means this study would help to identify both benefits and challenges faced by curriculum implementers and how the matter can be solved before they militate on the curriculum implementation process.

Finally, the project would also provide helpful information to the Ministry of Education on how to monitor school performance. Most importantly it would bring to light some challenges faced by students and possible remedies would be provided. Not only the

mentioned above would benefit even those who read and implement the strategies. However, despite benefiting others, the researcher would be the most beneficiary since he was directly involved in conducting the research. The results would also give insight to parents and school authorities on how best to reduce failure rate, hence may acquire all necessary resources for the subject. Evidence obtained could be used to rekindle the learner interest in map work as well as improving the pass rate.

1.7 Delimitation of the study

Delimitations in research refer to the limits created by the researcher in order to determine the scope and focus of a study. Considering the discussions on the impact of Geographic Information System (GIS) and digital tools on O level learners. This project has a number of delimitations that need addressing as they are significant in the study; these delimitations would include the consideration of theoretical frameworks, physical and geographical boundaries, learners' backgrounds, sample size, and data collection methods. The inclusion of factors would be crucial as the project would be influenced by these variables and considered during the implications of the study findings.

Theoretical constructs of the research would use perspectives of education that include recognising educational theories based on constructivism and experiential learning, which views learners as knowledge builders through their experiences and interactions within their environment. The engage learners as knowledge builders through activities that include geographic information systems and digital tools, these educational theories support the current state of research that indicates incorporating technology could enhance students' learning and understanding of geographical concepts, more so with the subsection of map work as indicated in the sample context. Thus, educational theories would consider a theoretical lens of the study that restricts the study from including other educational theories based on the theoretical framework of active engagement and the utilisation of technology.

The study was geographically delimited to Great Stride College, Harare, Zimbabwe in order to explore GIS in relation to the research, and through this delimitation it was important to include school-specific limitations as they apply to the educational context.. As an urban centre, Harare has its unique geographical characteristics and challenges, much of which would be somewhat different if the study were based in a rural area or another city or urban centre. As a result, while this research could certainly provide valuable information relating to the urban educational landscape, it might not account for the various complexities of learning shaped by other geographical realities. The current study would identify O level learners at Great Stride College, in relation to socio-economic status, exposure (or lack thereof) to geo-spatial technology education, educational background, and the implications for their experiences for engaging with questions based on map work using digital tools.. This research would draw from a specific sample size of O level learners at Great Stride College, selected from a stratified random sample to represent all classes and different socio-economic categories, meaning the focus of the study may not allow for understanding differences in learning styles, motivations, and culture from a wider audience with different social and educational experiences. For instance, Harare's specific socio-economic context may shape learner access/entitlements of technology, and how this influences their learning through GIS tools. The research would involve stratified sample size of O level learners from Great Stride College, which was derived from a composite sample of learners from Great Stride College, from classes of study in term two of the O level programme, selected in order to try and represent each class and social grouping the students relate. While this helped us to focus the research, this study may also have limited the scope of our findings. The small sample size limits recognition of the range of experiences about GIS and the use of digital tools, as well expecting the groups' conclusions to be objective and sensible. This research was also based on only one institution, and there was likely to be a lack of variety in perspectives around the role of technology in geography education. The data collected would be qualitative and quantitative from surveys, interviews and observation from the classroom use of GIS. Surveys will provide quantitative data on the learners' interaction with GIS and interviews

would provide qualitative data on learners' perceptions and barriers to the use of GIS. Classroom observations would allow for an understanding of how GIS tools are utilized in practice. All three data collection mechanisms are quite robust and yet limited. For instance, there was potential bias evident in the self-report evaluation data because learners might over- or under-estimate their prior knowledge and familiarity with GIS tools. Furthermore, observational data might only reflect snapshots of GIS usage and does not capture the perceived impact GIS had throughout their educational experience.

The delimitations mentioned above are indeed outwardly going to affect the outcome of the research study. The universe described above will provide rich evidence regarding the uptake of GIS and digital tools into geography education at Great Stride College. However, when it comes to the integrity of the actual results, the delimitations restrict the notion that the results are transferrable (in a general context) outside of the bounded context described above. The specific geographic and socio-economic setting of Harare might produce findings which reflect this locality, and was not reflective of trends in geography education in other contexts.

The delimitations were necessary for restricting scope and limits for unique case study boundaries and while important and necessary they represent trade-offs in terms of narrowing possibilities in the formulation of limitations. Recognising delimitations would be critical in interpreting results and implications that relate to geography and educational results broadly. Overall, the intended research has educational implications for geography as a subject area, offers knowledge that can inform future educational research, and contributes related knowledge to the discourse about using technology [tools] as active mechanisms for improving learning outcomes for learners studying O levels.

1.8 Limitation of the study

In carrying out the research, the researcher might encounter a number of challenges. The study might involve a limited number of participants, which could affect the representativeness of the

findings. A small sample size might result in findings that are not representative of the broader population of O level learners, potentially leading to biased conclusions. To mitigate the effects of small sample size, stratified random sampling was employed to ensure proportional representation of key demographic groups. In addition, qualitative methods, such as interviews and observations, are inherently subjective; to mitigate effects of qualitative methods, triangulation was used to enhance the validity of qualitative data by combining interviews, focus groups and standardized tests. The study was conducted over a single academic term, which might not provide sufficient time to observe long-term effects of GIS integration on learners' skills and engagement. The restricted duration of the study limits the ability to observe long term effects of GIS integration, such as sustained improvements in spatial thinking skills or changes in learner engagement over time. Short-term observations might not reflect sustained changes in behaviour or performance. Variability in access to technology among students may impact the outcomes of the study, variability in access to technology could disadvantage learners from low resource backgrounds, affecting their ability to fully engage with GIS tools and thus skewing performance outcomes. Response bias was also another challenge faced by the researcher; participants may have provided socially desirable responses during interviews or surveys, potentially affecting the accuracy of the findings. Also, absence of control group also affects the research findings; the lack of control group makes it difficult to isolate the effects of GIS integration from other factors that may impact map work performance. Factors such as teachers teaching experience and students prior knowledge of geography were not controlled for, which may influence the results.

1.9 Definition of key terms

Barriers or Challenges refers to any obstacle, hindrances or challenges to any progress and achievement. It was fair to state that there are many barriers to using GIS and digital tools in map work for O level. Furthermore, the barrier of a lack of teacher training and support and traditional forms of teaching inhibits the use of digital tools and GIS in O level students.

Curriculum integration Campbell and Lapham (2020) is an educational strategy for combining content and skills from different subjects into a coherent learning experience. This means that by focusing on the connections between the disciplines we explore how students can relate their learning to the real world experience (Lewis, 2020). As a result, this method enables them to consider ways to enhance critical thinking, problem solving and making connections with interdisciplinary learning. Geographical Information System can notably enhance the geography curriculum of Great Stride College through strategies such as curriculum alignment, hands-on learning, use of technology, and connecting with local organisations.

Digital tools Johnson (2019) are computer software applications and online resources for creating, analysing, visualising and sharing maps. Users can manipulate geographic information data and perform analysis on map data for creating interactive maps which enhances the learning experience and makes map work more accessible and enjoyable. Digital tools for map work can include ArcGIS, Google Earth, QGIS, StoryMapJS, GIS cloud and many more. Engagement is considered to be the level of participation, interest and motivation students demonstrate in their learning activities.

Engagement is considered to be related to better learning and understanding of the content area - Bernard (2020). In relation to map work and GIS, engagement is the way that learners engage with the mapping task, the digital GIS and map based tools they use to investigate geographic

concepts. Engagement is measured in this study, through observations, surveys and it is also seen, for example, with active engagement in GIS based project work or asking questions during task learning. In comparison High engagement usually leads to further learning, better retention of information, and an increased ability to demonstrate knowledge in real life applications (Subrata 15 Oct 2023).

Geographical Information Systems (GIS) is defined as a framework for gathering, managing, and analysing spatial and geographic data. GIS enables users to visualize, interpret, and understand patterns and relationships in data related to geographic locations (Victoria, 2020). GIS has an important place in education, as it progresses map work capabilities for O level students and promotes critical thinking and visual learning, promotes interactive learning, and helps learners develop problem-solving skills relating to map based work (MacMillan, 2021).

Map work is the use of maps by learners to analyse, interpret & comprehend geographical information. Map work involves a variety of tasks for geographic inquiry & problem-solving such as reading maps, creating maps that capture & display specific spatial data as well as the use of spatial data to address a question(s) (Leedey, 2019). Map work skills in geography education are important for learners to develop spatial awareness and critical thinking. Great Strides College learners experience challenges in addressing map work tasks, in particular interpreting scale and contour lines and discovering spatial patterns, map reading, distance calculations and comparing maps.

O level learners in Zimbabwe O level learners are also known for being final year O level students preparing for General Certificate of Education Ordinary level (O level) examinations (Mwamwenda, 2022). O level learners in Zimbabwe are usually aged between 16 and 18 years of

age and include a curriculum with subjects like geography, where map work and GIS content is required.

Technology integration is the technology supported educational use of technology to optimise and contextualise teaching and learning in pedagogical & social & cultural contexts. Technology integration is educationally beneficial as it promotes enhanced teaching & learning, improved students' and teaching outcomes as well as optimising educational approaches (MacMillan, 2021). The integration of improved technology like GIS and digital tools the learners would not only learn, but now visualise and explore map in an engaging and immersive way to improve spatial awareness and understanding of geographic concepts.

1.10 Chapter Summary

This study is organized into five chapters, with chapter one being the introduction which outlines the background of the study, the significance of the study and other important sub headings. The next chapter, chapter two reviews the existing literature on the use of GIS and digital tools in geography education, exploring existing research gaps and contextualizing the study within prior findings. The design of the study and methodology that was used in carrying out the study is outlined in chapter three. Chapter four comprises of presentation and analysis of data that was collected. Then chapter five is the summary of the findings based on the study objectives, conclusions, recommendations and suggestions for further research. References and appendices are presented at the end.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Introduction

This chapter reviews the existing literature on the impact of GIS and digital tools on learners' map work skills, barriers to their use and strategies for improving integration. Studies indicated that these technologies could enhance spatial reasoning, engagement and understanding of geographical concepts. However, barriers such as limited access to technology, insufficient teacher training and varying student proficiency hinder their effective use. While many studies highlight the positive outcomes of GIS integration, they often overlook context specific challenges and long-term effects of these practices. This review aims to address these gaps by focusing on the experiences of O level learners at Great Stride College, identifying strategies for overcoming barriers and improving the integration of GIS and digital tools in map work education. The review aims to provide a theoretical framework for understanding the benefits, challenges, and instructional strategies associated with GIS integration. The review was divided into two sections, theoretical frameworks and literature review and future directions in GIS education and the chapter summary.

2.1Theoretical framework

This section presents the theories informing the study. (Cuban & Peck, 2018) defined a theory as a set of interrelated constructs, definition and propositions that present a systematic view in a bid to explaining and predicting that phenomena. In context of the current study, the theoretical

frame work presents prior set of ideas explaining, decision, judgment and the challenges faced by learners in using GIS and digital tools in answering map work questions.

2.1.1 Constructivist Learning Theory

This section would explain the theoretical frameworks that form the basis of the GIS education study with the O level Geography learners with whom Great Stride College worked. The frameworks support the understanding of how GIS and some digital tools can enhance the engagement and outcomes for the O-level learners.

Constructivist learning theory indicates that learners create, revise and build knowledge based on experience and interactions with their surroundings. In the form of inquiry and exploration, constructivist learning theory considers the cumulative knowledge of prior experiences and understandings, along with the degree of awareness they have of this prior knowledge. Constructivist learning theory has been developed from the work of eminent educational theorists, such as Jean Piaget and Lev Vygotsky, for example. Piaget linked learning to cognitive developmental stages, while Vygotsky drew attention to the centrality of social interaction and developing knowledge through social circumstances, as opposed to learners going through life on their own constructing system models based solely on prior knowledge.

The relevance of constructivist learning theory to GIS education lies in the focus on active learning by discovering new knowledge through real-world situations. Students in GIS environments are using GIS technology to actively engage with global spatial data rather than print data. It seems that researchers affirm, "GIS gives students an authentic, interactive environment to investigate and analyse spatial data, so they could visualise relationships and

associations of data" (Bush, 2018). The hands-on approach lets learners tackle complex problem solving and critical thinking - important skills in interpreting maps and geographical information.

Learning theory's underpinning constructivism does not regard learners as passive vessels of content delivery, rather, in constructivism, learners actively engage with content, exploring and manipulating ideas in order to create their own understanding. Active engagement was fundamental to learning in geography, for example, learners could engage with real-life data using GIS tools, Macmillan (2019). Constructivism also highlights the importance of collaborative learning. For Vygotsky, the Zone of Proximal Development (ZPD), being socially situated, could enable learners to understand something higher by interacting with peers and more knowledgeable others. GIS often encompasses collaborative design with peers, allowing students to receive information and learn ideas from one another, Vygotsky, (2018).

Moreover, knowledge was constructed in context. It follows that learning experiences need to be meaningful to a learner's real life, situational context and environment. GIS is ideal for this type of contextualisation, it enables students to deal with local geographic issues and the related learning is more direct, Lowe (2021). The emphasis on reflection is particularly important for the constructive learning theory. Students need the opportunity to think about the experience they have had their learning paths and to reconstruct knowledge or understanding as new information emerges. The aim of GIS activities was engagement in critical reflection of their findings and what they have done to analyse what they have found, Kolb (2020).

However, despite the advantages of constructivism, criticism exists as to its usefulness in the GIS education context. The most common criticism of constructivist learning was the potential for cognitive overload. The openness of constructivist learning environments could sometimes seem

overwhelming to students, particularly for students who might not have an abundance of prior knowledge or experience working with GIS tools. As Johnson (2020) states, "students sometimes are lost in the data and tools they could use causing frustration and less than effective learning." This was particularly troubling for O level learners who might rely on more boundaries placed by their educators to develop their map work skills.

Both constructivism and constructivist approaches might inadvertently lead to positive bias in favour of students who have stronger prior knowledge or students who learn better in self-directed environments. Much criticism has been made over pedagogical practices that do not offer adequate scaffolding to allow ago to gain essential knowledge and skills to take advantage of the potential benefits GIS education may provide. As Adam (2020) states, "The lack of adequate teacher support…" in a constructivist framework would often just ignore educational inequalities and possibly even leave some students behind.

The aims of the study would focus on researching and determining the efficacy of GIS and digital tools in practicing map work skills with O level learners, identifying barriers to the effective integration of mapping skills and digital technologies, and providing ideas and recommendations to enable the improvement of these technologies within the learning context of Great Stride College. Constructivist learning theory would present a useful theoretical framework for creating opportunities in which GIS, as an example, could be used effectively to promote and engage students in opportunities for active learning. By considering the concepts of collaboration and experiential learning, it was hoped working through the study would establish ideas and suggestions for practitioners to support their delivery practices. This study was also attempting to address weaknesses in constructivist theory by finding a way to incorporate

structured scaffolding and guidance into GIS education. The goal was to find positive ways to scaffold learning experiences so all students, regardless of background knowledge, could engage and experience GIS technologies.

Constructivist theory was a good lens to use to demonstrate how GIS can enhance geography education. GIS tools encourage active engagement, social negotiation, contextual learning, and essential reflection in the learning process, all of which could promote deeper understanding of geographic concepts for students. Thus, this theoretical approach would inform the exploration of GIS integration on learning outcomes at Great Stride College.

2.1.2 Experiential Learning Theory

Experiential learning theory developed by Kolb (2019) provides a means of understanding learning through experience. Kolb's (2019) theory describes learning as a cyclical process of concrete experience, reflective observation, abstract conceptualisation, and active experimentation. With GIS, students could experience learning through common and creative forms of experiential learning; students use live or static geographic data, field experience, and project based learning. As a result, students would experience deeper understanding and retention of geographic concepts. Kolb's (2019) experiencing-learning theory (ELT) highlights the importance of experience in the learning experience. Kolb (2019) states that learning is a cyclical process encompassing four key stages - concrete experience, reflective observation, abstract conceptualisation, and active experimentation. The framework was particularly appropriate in the area of geography education, where students could connect hands-on (minds-on) experiences to better understand complex ideas.

For example, the concrete experience stage involves taking direct action during an activity or experience. In the previous example, students are completing a field study and using GIS tools to map local environmental features (e.g., rivers, parks). This experience was engaging and provides students some associations to the subject matter. Direct involvement in real-world activities offers learners more than an emotional connection; it provides a ways in which they can learn the material more fully, Kolb (2019).

Reflected observation was similar to the previous action, but here learners reflect on the observations they made and what they were feeling during the activity. For example, once students complete the GIS field study, they complete a group discussion to report their field observations and reflect on the challenges they faced using the GIS tools. This process of reflection allows students to critically think about their experiences while leading to greater self-discovery and improved understanding of geographic principles, Leedey (2019).

In addition, it could be helpful to clarify for learners, the process of abstract conceptualisation, involves categorizing or developing theories or concepts based on their reflections. For example, after having the opportunity to talk about their field observations in a group, students then write a report to correlate their activities or observations with the broader geographic concepts, such as ecosystem dynamics or urban planning. By connecting their concrete active experiences with more abstract theoretical frameworks, learners are able to better understand complex ideas and visualize their reality, Baker et al. (2018).

Finally, active experimentation involves learners using what they have just learned and applying it to unfamiliar circumstances or contexts. For example, in using the GIS tools, students can provide proposals to show how they might address local environmental issues (urban heat

islands, flooding) that we explored in the field study and features of the local environment all the while, applying their knowledge to develop actionable plans. This stage reinforces the learning process, develops independent learners, and gives learners authority over their learning process (innovation), Roche, (2019).

Integrating GIS into geography education was an ideal way to combine the principles of experiential learning, GIS tools allow students to actively engage and work with the data and perform actions, using the tools to analyse and display geographic phenomena (Lewis, 2019). For example, students could compare historical maps of an area with current-day satellite imagery to track changing land use over time. Students will not only complete GIS projects but then have the opportunity to reflect if on the process of learning through experience, what worked and didn't work. This structured reflection gives students deeper clarification and initiates critical thinking (Kolb, 2018). In addition, as students are using GIS to work with their "real life" data, they can utilize their learning and connect back to theory such as spatial distribution and geographic patterns. For example, in this type of GIS project students could work with demographic data to look at patterns in development growth. Finally, once the students have experienced learning through the GIS project for the concrete experience and had the opportunity to reflect for reflective observation, they can apply what they have learned to create inventive solutions for geographic challenges for the active experimentation component. For example, they may use GIS to establish sites within their community to plan a community garden that will work around food deserts. This practical experience allows students to feel a sense of agency and relevance to their learning.

Experiential Learning Theory offers a robust justification for supporting the rationale, as with its circular process of experiencing, reflecting, conceptualizing, and experimenting learning and experience, ELT implies GIS has the potential to positively engage and impact the students' understanding of geography. By applying the principles of ELT it will help facilitate exploration of the effect of GIS integration on learning outcomes at Great Stride College and contribute to the promotion of a more successful and relevant experiences in Geography education.

2.2. Impacts of GIS and digital tools on student performance in map work related questions.

The implementation of Geographic Information Systems (GIS) and digital tools in geographical education has been areas of interest in research especially its effect on student's spatial skills in regard to performing map work tasks. The aim of this literature review was to consider the specific effects of GIS on O level learners in Zimbabwe and find out the level of engagement, skill levels, educational achievement, as well as illustrating the level of improvement in map work performance. The review also addressed the biases of the studies undertaken and the comparative analysis of various scholars in regard to Zimbabwean education.

2.2.1 Improved Spatial Skills

Research has illustrated that GIS improves students' spatial skills, which are vital for tasks requiring map work. For example, using Baker et al. (2018) GIS-linked map activities, students understand the topographic features and relationships and improve skills to derive meaning from spatial map representations. In their work on map work using GIS, Macmillan (2019) mentioned that students using GIS tools improved all spatial thinking ability typologies to better interpret

describes and critically reflect on points on a map, compared to their counterparts using traditional methods alone. One study shows that spatial skills are essential to success in map work, and that students using GIS tools consistently demonstrated significantly better performance, resulting in improved spatial skills. Colic (2018) reported that students exposed to GIS-based learning activities were more effective when it came to interpreting topographic maps and recognising spatial patterns than those were working only based on traditional mapping exercises. This improvement was attributed to the participatory aspect of GIS that engages students with data more dynamically in different dimensions.

While GIS has produced positive evidence, researchers need to also consider different potential biases in the studies that focused only on learning experiences associated with GIS and digital tools. One challenge was sample size and diversity of participants. It was common for researchers to draw on limited samples or to have sampled participants lack demographic diversity. While this doesn't preclude findings being drawn from students in the studies, it often limits the readers' abilities to relate the findings to their own students. For example, if a study only included students from a specific academic context or region, this sample would not accurately portray the experiences of students more broadly (Graham et al., 2018).

Furthermore, there are additional biases associated with the kinds of map work tasks that students are undertaking. In some studies, the researchers may have used overly simple tasks that may not only under-challenge students but do not consider the work tasks that exist in real-life practices. The limitations of the tasks available to students can create inflated perceptions regarding the spatial capabilities of the students. For example, if the tasks you use with students do not require higher-order thinking, students would not require those literacies (Creswell,

2009). Our thinking has to be more nuanced when we are assessing how and to what extent, GIS and digital tools assist spatial skills. The advancement of spatial skills by using GIS was essential for students performing tasks connected with the map work aspect of the course. GIS offers not only interactivity and real-world learning opportunities, GIS was capable of developing student spatial skills while providing them with the opportunity to develop their own geographical concepts as they would be expected to do in future studies or work. The development of these skills would contribute to developing meanings in the geographical concepts and heightening performance in engaging with geography in education also.

2.2.2 Increased engagement and motivation

To a greater extent Johnson (2019) claims that digital technologies are a form of media and entertainment. Studies examining the use of Geographic Information Systems (GIS) and digital tools in geography have been shown to improve engagement and motivation in students completing tasks related to map work. Engagement and motivation are important for creating a positive learning experience and hopefully increasing active student participation in geography education. GIS and digital tools increase students' interactive learning environments. GIS tools offer students an engaging, dynamic learning experience that draws on students' attention. Bernard (2019) claims that students are more likely to actively engage with content when they are completing projects using hands-on GIS technology as opposed to more traditional methods such as maps, pictures, and lectures. For example, completing projects that are based on mapping and investigating local environmental problems and project that require students to analyse spatial patterns as they become more concrete and relevant to the students' from their own lens, they will be more inclined to consider such content more engaging or interesting.

In addition GIS and digital tools have the capacity to heighten real-world applications among learners. The ability to apply GIS to real world problems increased their motivation for study. When students see that they could apply their learning to a real-world context they will be more likely to invest time and energy in the tasks set for them. For example, projects related to analysing demographic trends, or urban planning issues could emphasize where students studies link to the world they are familiar with - providing a point of purpose to their actions. Another point was that using GIS provides students with agency over their learning. When students participate in making their own maps or completing their own analysis, they have some level of authorisation or ownership, which might assist them in being more motivated. Ownership might refer to individual students taking initiative and ownership when project related activities are personally appealing, Victoria (2018).

It needs to be acknowledged that whilst the motivation of students' may be impacted positively by GIS and digital tools, there are several studies indicate inherent biases when examining these experiences. One major problem that arises was diversity among participants. Very few GIS studies examine diversity among learner demographics. Most students in GIS studies appear to come from quite homogenous settings, whether that was in terms of a participant population, which means there was limited usefulness of the findings from studies examining not diversely represented learners from student participants. So for example, if research randomises predominantly middle class students from middle class suburbs, it cannot claim to tell us anything about as variety of students, Graham et al, (2018). Using under-represented demographics can skew findings of motivation without paying attention to counterfactual factors such as socio economic status or cultural demographic.

These polarized views present complexity to the relationship between technology and motivation and it was uncertain if the efficiencies gained from GIS outweigh the disadvantages depending on how it was embedded and the various contexts in which it was implemented. The researcher believes that the use of digital tools assists in generating lively animated lessons, resulting in students engaged for longer, and as learners' attention has been captured by means of using rapidly available several digital tools and software then this group could be controlled as all that energy was exhausted with the use of digital tools.

2.2.3 Development of critical thinking skills

The utilisation of Geographic Information Systems (GIS) and digital tools in geography education has been known to be beneficial to students who are tasked with map work and afford students higher levels of critical thinking skills. Critical thinking was the key to thinking through information, assessing evidence, and ultimately determining a decision based on what data was provided, which is essential in becoming a geographer.

Using GIS fosters analytical thinking in students. Students need to interpret and interact with spatial data while employing critical thinking analytical skills. Baker et al. (2018) stated that students that utilize GIS are somewhat better than others at thinking through geographic information, noticing patterns and concluding by assessing their time, location and analyses. All of which was key to effective map thinking/ interpretation or general decision making. In addition to developing analytical thinking skills, These GIS and digital tools foster problem solving in students. Thinking using GIS supports problem solving skills development. Research by Zhang et al. (2019) indicates that when students utilize GIS research, they tend to be faced

with complex spatial problems for thought and researching innovative solutions. For example, if students were tasked with analysing urbanization and local ecosystem effects, they need to consider factors and support such a decision, all of which could help problem solving.

GIS, allows students to come up with informative questions and hypotheses, and test question or hypotheses through analysing real world data. Students are testing their hypotheses and conclusions from data collected; and that was critical thinking. Chandra (2018) found increased performance and capability when student utilized GIS tools; students would more successfully evaluate their spatial data, hypotheses and interpretations, rather than general understanding of conceptual geographic knowledge. Connected to increased performance, GIS also encourages students to connect geographic concepts to other disciplines, for example; environmental science, economics and sociology. This approach towards learning, demands students to think critically about how physical, human, spatial processes and events work in relation to one another (Bush et al., 2019). For example, when students assess the social and economic impacts of a natural disaster (GIS), they must analyse numerous, competing perspectives and datasets of related events or processes - supporting a 'bigger picture' understanding of multiple layers of issues.

2.3 Barriers learners encounter when using GIS and digital tools

Although Geographic Information Systems (GIS) and digital use could greatly benefit geography education, learners often face barriers when attempting to do map work using these technologies. In addition, to cognitive overload, students could encounter technical difficulties, lack of training, accessibility difficulties, and cognitive overload.

2.3.1 Technical Difficulties

Technical difficulties are a serious barrier to learners attempting to engage in map work tasks using GIS and digital use, particularly in urban areas such as Harare. Poor technical difficulties can arise from various sources, including hardware problems, software problems, and user experience problems. These considerations could also make cognitive overload appear more extreme, which relates to a situation in which a learner's cognitive resources are loaded heavily so that they are unable to process information.

As well as having poor connectivity, software compatibility and functionality could increase the barriers to learners in schools. Many students have hardware or installation issues, usually leading to difficulties around software functioning. According to Roche et al. (2018), the GIS software setup often causes students a great deal of frustration and, as a consequence, disengagement. Software bugs (various bugs tied to software with multiple versions), different operating systems (compatibility issues between Apple, Windows, or Linux) and updates could impede that learning process and, as a result, discourage students from completing map work tasks satisfactorily (especially at Great Stride College, in Harare). Similarly, data management issues can prove challenging to students in schools. The expectation of GIS was that users will manage and manipulate the large amounts of data, which could be overwhelming for many students. The prospect of issues such as imports, formatting and understanding the data structure can limit many students.

Technical issues could greatly diminish the students' confidence and dispositions towards learning GIS, or other digital tools. When students run into software glitches or problems, along with data management issues, and have limited or no access to technical support, they might

simply not be able to complete the mapping activity. For example, if they are using GIS, they would need to engage concepts of platform, GIS, and connecting it to broader geography concepts. Therefore, students might face (especially in their first couple of lessons where they may not have even had the chance to develop an understanding of using GIS as a part of their learning) a struggle involving the confusion and frustration faced. Therefore, if we could take away this additional layer of struggle and focus on using quality relevant training and support systems, along with more user-friendly software options, it might help geography educators improve student learning experiences by integrating GIS. In total, if students could at least reduce the amount of technical trouble, they could learn how to think and to include GIS as part of their geography learning.

2.3.2 Limited Training and Support

The lack of training and professional, technical support was one of the barriers to the inclusion of GIS and Digital tools into geography lessons. Adam (2020) indicated the majority of secondary school teachers, who said they were unable to use GIS in their lessons, would like professional development, where teachers could update their knowledge and skill in the use of digital tools. The absence of training and support for both educators and students was a major obstacle when using Geographic Information Systems (GIS) and digital tools in map work tasks. This absence of training and support could limit how the technologies could quickly become integrated in geography education, resulting in absent learning for students. Lack of adequate training for teachers in schools poses another issue for teachers. Many educators do not have sufficient training in GIS technologies, which could lead to ineffective and sometimes improper teaching practices. Kerski (2018) highlighted that teachers did not view themselves as competent in

incorporating GIS into their lessons, resulting in difficulties in classroom implementation. Without a good understanding of GIS, teachers often lack the confidence to lead students and potentially realize the benefits of the tools.

In addition to inadequate educator support, lack of student support was another aspect of the challenge for students. When students encounter challenges using GIS and have no support, the students' challenges can be compounded. Bernard (2019) noted that many educational institutions are not able to provide robust resources and support for students learning to use GIS. Without support, many students might experience frustration and disconnection, maybe feeling that they are wandering through the technology with no sense of direction. Furthermore the limited opportunities for teachers to engage in professional development learning about GIS and digital tools are a major concern. Roche et al. (2018), too many educators do not have access to training or workshops focused on GIS, which limits their opportunities to stay up to date with new technologies. This absence of training can exacerbate gaps in skills and prevent effective teaching. Zimbabwe has CDTS that recommend using digital tools in the teaching and learning of geography, but educators do not have the technical know-how on how to do this.

Curricular Integration Challenges was also another issue, and without training, educators might find it difficult to integrate GIS into the curriculum. Zhang et al (2018) noted that teachers who lack familiarity with GIS tools might revert to conventional teaching methods, hence excluding interactive and relevant learning experiences for students. This pretension only perpetuates out dated pedagogical practices. Similarly, workshops on the use of digital tools in particular GIS usage have been availed in many secondary schools (Mpofu, 2020), but not all educators have received these workshops. Thus the proposal in this study was to find out if the geography

teachers at Great Stride College have been inducted to be able to rope in digital tools in teaching and learning in particular their map work aspect of their discipline.

2.3.3 Accessibility issues

Accessibility issues are a major barrier that affects the ability of learners to use Geographic Information Systems (GIS) and digital tools effectively to do map work tasks particularly in Zimbabwe. The problems associated with accessibility to GIS and digital tools might arise from under-resourced locations, technological inequity, and not having access to the essential equipment or software. Too many schools especially under-funded schools, lack the hardware and software to successfully implement GIS into practice. For example, as noted by Bernard (2019) the technological advancements could and do create unequal learning opportunities for students. Schools especially those without useful computer labs, and GIS software licences, might reduce opportunities for students to engage with GIS, which creates extensive reputational gaps in learning.

Another issue was poor Internet Connectivity. As Cuban (20018) states, the Internet is essential with many GIS applications, and that can hinder students with broadband requirements, especially in Zimbabwe, from doing assignments using various online resources or accessing particular data.

This limitation could leave some students at a disadvantage, unable to participate fully in GIS-based tasks. In addition, accessibility issues also encompass the need for inclusive design in GIS tools. Some software might not be user-friendly for students with disabilities, creating additional barriers. As noted by Doherty et al. (2018), it is essential for GIS developers to consider the

diverse needs of all users to ensure that every student can engage with these technologies effectively. The study also indicated that the available computers were mostly owned by school administrators, a situation that made impossible for them to effectively integrate them in the teaching and learning situation. In Zimbabwe the researcher, believes that some of the secondary schools are so impoverished that though teachers might improvise their own laptops, but it requires school efforts for use of these digital tools in teaching and learning to materialize. This study sought to authenticate if teachers at Great Stride College are well versed in the use of GIS in teaching, particularly map work.

2.3.4 Lack of adequate time to use GIS and digital tools

Preparing a lesson in which GIS and digital tools are to be used needs a lot of time, and thus chews up time for didactical preparations, or time of being physically available to the students (Johnson, 2020). This means that inadequate time might hinder the teacher from pre testing digital tools and GIS software before the lessons begin. There was need for ample time to devise alternative strategies in case of failure, as well as trial and error of many times (Cuban, 2019). These assertions entail that the use of GIS and digital tools demands more than double the normal time used by teachers when they engage learners in their absence. Similarly, Kruger (2019) opine that educators who intend to use GIS and digital tools should spare adequate time for planning how they intend to execute their lessons, as a way of avoiding presentation of inconsequential subject matter. This study sought to establish if teachers at Great Stride College have adequate time rope in GIs and digital tools in teaching map work.

2.3.5 over enrolment

In most African learning institutions, the number of students per class was not consistent with prescribed professional standards (Mwamwenda, 2020); making it a mammoth task for educators to use digital tools effectively (Victoria, 2017). In the Zimbabwean setting, most classes are characteristic with large numbers and this poses challenges for educators who might want to integrate GIS assisted instruction in their lessons (Creswell, 2019). These overenrolled classed consequently force the majority of educators to resort to classical teaching methodologies that suit over-crowded classes (Lewis, 2019). The researcher observed that the lecture mode of instruction, which was heavily teacher-centred, was the most common method prevalent in most secondary schools when teaching map work, Geography. Thus, this study sought to determine if geography classes at Great Stride College are not overcrowded to impede the use of GIS in the teaching and learning process.

2.4 The integration of technology in map work be improved for better educational outcomes

The integration of Geographic Information Systems (GIS) and digital tools in map work has the potential to enhance geography education significantly. However, to maximize their effectiveness, it was essential to address the existing challenges and improve their implementation in educational settings. This literature review explores strategies for enhancing the integration of GIS and digital tools in map work.

2.4.1 Professional development for educators

One of the recommended strategies to fight knowledge deficiency in the use GIS and digital tools was to encourage school heads to accord teachers intending to rope in the use of digital

tools in their lessons an opportunity to upgrade themselves through workshops and seminars. Creswell (2018) acknowledges that teachers might be interested in using digital tools but without refresher training, it would be an uphill battle for them to cope up and live to the expected standards. Many educators lack the foundational knowledge necessary to use GIS effectively in their teaching. Colic (2018) emphasises that targeted training programs focusing on both the technical aspects of GIS and pedagogical strategies are crucial. These programs should not only teach how to use the software but also how to integrate it meaningfully into the curriculum. Comprehensive training prepares educators to utilize GIS more effectively, ensuring that technology enhances, rather than complicates, the learning process.

In addition, continuous support after initial training was vital for sustaining educators' skills. Bernard (2018) notes that on-going access to resources, such as online tutorials, forums, and expert consultations, could help teachers feel more confident in using GIS tools. This support could also assist in troubleshooting technical issues as they arise. On-going support and resources are crucial for maintaining educators' proficiency in GIS, leading to more effective implementation in the classroom.

In addition, incorporation of technology in training was also important, utilizing digital tools in professional development could enhance educators' learning experiences. Bush (2019) suggests that hands-on workshops where teachers use GIS technology during training could lead to greater understanding and retention of skills. This approach models the use of technology in a way that educators could replicate in their classrooms. Incorporating technology into training enhances learning outcomes for educators, equipping them with the skills necessary to integrate GIS effectively. This study sought to verify if geography teachers at Great Stride College have been work shopped to enable them to integrate digital tools in their lessons.

2.4.2 Curriculum alignment and integration

Aligning and integrating Geographic Information Systems (GIS) and digital tools into the existing geography curriculum are important for their educational impact to be fully maximised. Curriculum alignment would ensure technology was facilitating learning and not an unrelated activity. For GIS and digital tools to be effective means that they need to be aligned operationally with the geography curriculum if they are designed to meet the learning objectives. Bernard (2019) states that the direct connection of GIS activities to the geographic curriculum goals means students identify relevance to using technology to address geographic concepts. This alignment leads to a deeper understanding of concepts and retention of knowledge. Making GIS aligned to curriculum objectives will support a meaningful way to engage learners and make it more relevant.

In addition, significance when using GIS was to create rich learning experiences through interdisciplinary projects. Kolb (2018) suggests that geography when combined with science, mathematics, and social studies allows students to apply GIS skills in meaningful ways. Integration of GIS across disciplines broadens students' conceptual understanding and drives home the interconnectedness of knowledge. The interdisciplinary integration of GIS fosters a conceptually richer understanding of geography that also enhances higher-level thinking and application skills. The development of Inquiry-based learning was also a vital interrelated component. Inquiry projects that incorporate GIS put students in the role of a hands-on explorer. According to Roche (2018), when students engage with GIS to examine real-world geographic issues, they learn transferable skills in problem-solving and in critical analysis. Exploration and inquiry allow for more active engagement which leads to a deeper understanding of the material.

Inquiry-based learning through GIS was a way to improve participation and critical thinking, and as an outcome a student's productivity could be improved. Thus, this study was intended to confirm whether there exists support in acquiring GIS and digital tools that will support learning and teaching at Great Stride College.

2.4.3 Enhanced access to resources

To a larger degree, without the collaboration of other educational stakeholders, including school leadership, sponsors and the government ministry responsible for education, the incorporation of digital resources in the teaching and learning of map work would be an impossible endeavour (Casey, 2018). Working towards improving the availability of resources was also critical to support the successful implementation of Geographic Information Systems (GIS) and digital resources in map work. When students and educators have the appropriate resources and relationships, the learning experience becomes much more engaging and useful instead of filling disappointing gap in terms of learning. Having the proper technology infrastructure was also essential. Schools could invest in technology infrastructure more effectively; in terms of a dedicated computer, accessing software licenses and reliable internet. For example, Roche et al. (2015) found that the provision of dedicated computer labs, all of which provided GIS software resulted in students being better able to engage with achieving mapping tasks. Technology infrastructure provision ensures that all students have access to the tools for learning effectively. Ultimately the deployment of technology infrastructure qualifies accessibility and equity, and allows all students to develop a range of GIS and digital tool competencies. In addition, open education could greatly increase accessibility for different GIS resources. There are a number of web addresses such as, ArcGIS Online that facilitate free access to multiple GIS tools, datasets

and lesson suggestions. For example, the National Geographic Society has GIS activities and digital datasets available freely for educators to use in their classrooms (Bush, 2018). The increased access to high-quality open educational resources broadens the availability of GIS education for schools and more students could participate without costly compromises. Furthermore, partnerships with local organisations, colleges and universities and government agencies could also increase availability and expertise. Partnerships with local environment agencies could give students access to real time data and provide GIS mapping-based projects locally. This relevance supports educational meaningfulness, but they also afford GIS learning with qualitatively robust datasets. Partnerships constructed by external organisations materially increase the educational experience and access student to real-time data. The researcher notes with regret that most of the digital tools such as computers donated in schools to enhance the teaching and learning of geography are now considerably out dated and becoming defunct owing lack of maintenance and replacement. Consequently, this research intended to explore if there are alternatives to assist the acquisition of digital tools to facilitate teaching and learning at Great Stride College.

2.4.4 Student centred learning approaches

Geographic information systems (GIS) and digital learning tools are changing the way we map, particularly in educational contexts. Students could actively participate in a student-centred learning (SCL) approach which not only strengthens engagement but also fosters greater opportunities for critical thinking about place and space through GIS education. This literature review looks at the convergence of SCL and GIS, with an overview of some strategies, benefits, and challenges of using digital tools in mapping.

When we refer to SCL in the context of GIS, we are referring to engaging students in their own learning through engaging, hands-on experiences with GIS tools to map data. Mackmillan (2018) explains that SCL provides students with the opportunity to have active roles in exploring geographic data, enabling them to gain a better appreciation and understanding of spatial relationships and geographic concepts. A SCL approach allows students to take ownership of their learning by allowing students to ask questions, make investigations based on spatial information, analyse their data, and formulate conclusions based on what they investigated. A SCL approach in GIS education facilitates active engagement of students in the learning process, which could foster students being better equipped to understand geographic concepts.

The use of GIS and SCL was beneficial in many ways. Bernard (2019) highlighted that GIS tools could foster spatial thinking and spatial analytic skills for the students. Students are working with data that they could then leverage to tackle real-world problems, which supports critical problem solving skills and more deeply informs their understanding of complex geographic issues. In addition, we could also draw a connection to student engagement, as GIS activities typically

spark student interest and make learning relevant and impactful. Using GIS and SCL cultivates critical thinking, spatial reasoning and student engagement. There are effective approaches to support student-centred learning with GIS through inquiry-based work, collaborative learning, and technology. Roche et al. (2022) noted the benefits of project-based learning and working in teams where students have to engage with and present on geographic data. By offering opportunities for collaboration, students improved their learning outcomes while honing their teamwork and communication skills. The combination of project-based learning and collaboration with GIS in education leads to improved engagement and learning outcomes.

Nonetheless, there are issues related to transitioning to a student-centred constructivist approach that includes GIS. A shared concern among educators was a lack of training and/or resources to effectively implement GIS education with a collaborative and constructivist focus. Leedy (2020) pointed out with a lack of professional development involving GIS tools; educators might rely on traditional, non-student-centred teaching, so there was a lost opportunity for student-centred learning. Additionally, educators in some contexts might be limited in access to technology or data. Recognising professional learning and access to resources was of utmost importance when overcoming challenges with student-centred GIS.

To support student-centred learning with GIS, technology could add value. Web-based GIS solutions like ArcGIS Online allow students to have access to and manipulate geographic data on the go or from anywhere, creating dynamic opportunities to enable student-centred flexible learning experiences. In relation to engaged student-centred learning, Tang (2018) pointed out that technology could facilitate interactive visualisations and real-time data analysis. Similarly,

technology allows for flexible access to GIS data, interactive learning experiences, and increased student engagement with GIS.

Integrating GIS and digital tools within student-centred learning approaches offers considerable potential for educational outcomes related with map work and education. Student-centred learning with GIS would allow engagement, collaboration, and thinking critically while promoting student agency and success with geographic issues. At the same time, work needs to be undertaken on challenges regarding access to professional development and resources in order to implement GIS effectively. On-going exploration in this area would facilitate the evolution of GIS education while also advocating for student agency in understanding geographic concepts.

2.5 Gaps in the Literature

The challenges required in depth investigation to enlighten the challenges faced by schools in using digital tools and GIS in the teaching and learning of map work. The researcher considered inadequate human resource, over enrolment, learner's attitude towards the use of digital tools in geography and the availability of learning facilities and infrastructure to have a great influence in the whole process of teaching and learning using digital tools. The studies conducted were not in Harare, and most of them were not in secondary education. Those researches had put much attention in other factors such as lack of resources and technical difficulties.

2.6 Chapter summary

This chapter has shown the impact of GIS and digital tools in responding to map work questions at ordinary level. It highlighted how the integration of technology in map work be improved for

better educational outcomes. The chapter also revealed the barriers learners encounter when using GIS and digital tools such as lack of training and support and accessibility issues. Lastly the research gap was identified whereby the researcher wanted to investigate the challenges faced by learners in the use of GIS and digital tools in answering map work questions. The next chapter is devoted to the research methodology, this chapter outlines the methods used to assess the integration of GIS and digital tools on O level learners map work performance, evaluate the its impact on learner's map work skills and to identify the barriers to its effective use. The research in this section focused on methods of collecting data, mixed methodology was used and the research is both qualitative and quantitative.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter is going to describe the methodology, the research design that was used in this study. This chapter describes the methods that were used to assess the inclusion of GIS and digital tools on O level learners map work performance evaluate its effect on learner's map work skills and identify the barriers to include them effectively. The research covered in this chapter focused on methods of collecting data, the mixed methodology was used and the research is both qualitative and quantitative. Mixed research design uses qualitative and quantitative methods to give a more holistic understanding of the research problem. Mixed methodology captures the width of participant's experiences while producing statistical data to support the findings. This chapter was split up into the following sections, research design, target population, sample and sampling methods, data collection methods, data presentation and analysis, ethical considerations and chapter summary.

3.1 Mixed Method Research approach

The study used a mixed method approach which was an approach to research that consists of collecting, analysing, and integrating quantitative and qualitative data (Creswell, 2019). The foundation of this premise was that the combination of quantitative and qualitative approaches could enhance a researcher's understanding of a research problem that cannot be achieved by either approach alone. As such, mixed methods research was that it collected, analyses and

interprets both quantitative and qualitative data in a single study or series of studies that investigate the same event, phenomenon or problem.

The quantitative paradigm rests on positivism, while qualitative research rests on constructivism (Johnson, 2019). Quantitative research is a type of research that entails deciding what to study, asking narrow specific questions, collecting quantifiable data from participants, analysing these numbers using statistics, and conducting the inquiry in an unbiased objective way (Colic, 2018). Qualitative research is a type of research that entails relying on participants' views, asking broad general questions, collecting data that consists of a lot of words from the participants, describing and analysing the words for themes, and conducting the inquiry in a biased subjective way (Lewis, 2019). Mixed methods research has much potential for practitioners who would prefer researchers move closer to the association methods (i.e., quantitative methods), and develop methods that look more like what researchers actually do (i.e., qualitative methods) in their practice (Rosen, 2020). Pragmatism research, as the third paradigm of research could also help to connect the quantitative (scientific) use of science to the qualitative (interpretive) use of science. Many of the research questions - and combinations of such questions are best or at least most partially, answered through mixed research (Graham, 2020).

The aim here was to gain in breadth and depth of understanding and corroboration, while offsetting the weaknesses inherent to using each approach by itself. This approach offers the benefit of possibility of triangulation which allowed the researcher to identify aspects of a phenomenon more accurately by approaching it from different points using different methods and techniques. The use of this approach was necessitated by the need to look at the research question from different angles, and clarify unexpected findings and potential contradictions

(Kolb, 2019). There was also need to elaborate, clarify and build on findings from other methods. Creswell (2019) posits that this approach provides a more complete and comprehensive understanding of the research problem than either qualitative or quantitative approaches alone. Therefore, in this study the researcher has opted to use mixed approach because of several advantages that it offers.

3.2 Research design

Research design refers to the overall framework or blueprint that outlines how a research study will be conducted. It encompasses the methods and procedures for collecting, measuring and analysing data to answer specific research questions. The researcher used a convergent parallel design that integrates both qualitative and quantitative data collection and analysis.

3.2.1 Convergent parallel design

Convergent parallel design is a mixed-methods research approach that integrates both qualitative and quantitative data collection and analysis. This design enables researchers to gain a comprehensive understanding of a phenomenon by collecting different types of data simultaneously. The qualitative and quantitative strands of the research are analysed separately but are then compared and contrasted to provide a fuller picture of the research questions at hand. The first research question explored how GIS and digital mapping tools enhanced O level learner's spatial literacy. Quantitative surveys measured changes inn spatial literacy, while qualitative interviews offered insights into student and teacher experiences. In addition, quantitative assessments identified specific barriers, while qualitative narratives revealed underlying factors affecting implementation. Therefore, the convergent parallel design facilitated

a nuanced understanding of how GIS tools impacted education, highlighting successes and challenges at Great Stride College.

3.3 Target population

The target population for this study consists of 15 O level learners currently enrolled in O level geography at Great Stride College, aged between 15 to 18 years and four geography teachers selected from Great Stride College, with experience in teaching map work and integrated GIS and digital tools into their curriculum. The study considers a balanced representation of genders among learners, 7 boys and 8 girls to ensure that any findings related to GIS are not biased by gender differences in performance. This specific selection was made to align closely with the study's objective, which focus on understanding the impact of GIS and digital tools on map work tasks. The selection also takes into account the socio economic backgrounds of learners for example access to technology and educational resources could vary significantly. The study focused on understanding how Geographical Information Systems (GIS) and digital tools influence student's performance to map work related questions.

3.4 Sample size and Sampling techniques

According to Chandra (2019) sampling is the selection of a portion of population such that the selected portion represents the population adequately. The research employed stratified random sampling technique in selecting respondents. The population was segregated into several mutually exclusive subpopulations or strata.

3.4.1 Sample size

The sample size for the study will include 15 O level geography learners. This sample size has been determined in order to provide adequate statistical power for analysis of the quantitative data and still provide useful qualitative insights. Four geography teachers would be selected to participate in semi structured interviews. The smaller sample size was desired due to the qualitative nature of the research study. This would enable an in-depth examination of teacher's experience and perceptions. A sample size of 15 O level learners for the study creates some issues regarding the possibility of bias. To ensure that the sample would be as representative as possible, steps taken to obtain a non-biased sample would have to take into account a variety of demographic factors including but not limited gender, socio economic background and academic success.

3.4.2 Sampling techniques

This study employed stratified random sampling for learners and purposive sampling for teachers in order to achieve a comprehensive data collection plan. Stratified random sampling was used to ensure that different subgroups within the population could be represented (Barker, 2020). Stratified random sampling acknowledges diversity within a demographic, for example gender and location. Gender was representative of both male and female learners; location allowed for learners from different areas reflecting different educational contexts. The population of O level learners would be divided into strata according to the demographic attributes used to identify the learners. Random sample at each stratum would be taken according to the proportions of the population. Purposive sampling was used to obtain participants who met specific requirements

that were determined essential for the study. The participants selected according to purposive sampling were teachers who have experience in teaching geography and have also used GIS tools within their teaching. The teachers chosen also indicated a willingness to participate as well as were able to provide valuable reflections based on their experience of using digital tools while conducting map work.

3.5 Data Collection Instruments

The researcher employed various instruments including surveys, standardized tests, focus groups and semi-structured interviews which were advantageous in that it took a comprehensive collection approach to the data. The triangulation of these methods allow for a robust analysis of both quantitative and qualitative data improving the findings of the study regarding the impact of GIS and digital tools on O level learners map work responses which are referenced via appendices at the end of this study.

3.5.1 Questionnaire

The questionnaires were devised to be utilized as the main tool for collecting data from the participants. A questionnaire is an example of a written instrument that asks the same specific question of all the individuals in the sample population, and can be completed by the respondents at their own pace. The questionnaires developed were to collect quantitative data from O level learners regarding their experiences of GIS and digital tools. These questionnaires consisted of closed ended questions, for example, multiple-choice questions and open-ended questions that allowed the respondents to share their opinions and experiences, Peck (2018). Questionnaires are

efficient at collecting a large amount of data quickly, and could be administered in many ways including online and face to face. The pre-intervention survey would capture information to assess student's attitudes towards map work, student's self-reported capabilities to use Geographic Information System (GIS) and digital tools, and student's experiences with these technologies, and GIS and digital tools. The questionnaire contains three main sections: demographic information; attitudes towards map work; and self-reported capabilities with GIS, and digital tools. This questionnaire was administered to a random sample of O-level learners at Great Stride College.

3.5.2 Interview guide

The aim of this guide was to initiate conversations with teachers at Great Stride College about their experiences and views on using GIS (geographic information system) and digital mapping tools in their educational programs. This guide was organized according to high-level research questions that explore the impacts, problems and potential enhancements related to GIS. These discussions might touch on specific examples in which teachers saw students benefitting from GIS, what technical issues they faced during lessons as well as the adequacy of training for using GIS and digital mapping tools. Teachers would also be asked to illustrate how GIS was currently used in their plans and this walkthrough would interrogate teachers' thinking on potential solutions to improve the use of GIS and digital mapping tools. The intention of this interview would be to collect rich detail about the experiences from Great Stride on the impacts, challenges and possible improvement related to the use of GIS and digital mapping tools in the college.

3.6 Data Collection Procedure

The study involved preparation of a project proposal, which was approved by lecturer in charge. The study includes a comprehensive data collection procedure, which includes a systematic process that will measure the influence of uses of Geographic Information Systems (GIS) and digital tools on O level learners' map work skills. The first step in the process was the careful preparation of survey, standardized tests, focus group discussions and semi-structured interviews. Each data collection instrument was designed to use both qualitative and quantitative data for a comprehensive insight into the learners' experiences. The data collection qualitative aspects were conducted over a period of 3 weeks from 8 March and completed 30 March 2025. During the data collection phase of the study, a number of documents were distributed to engage participants, such as printed questionnaires, informed consent forms, instruction manuals and promotional materials. The data procedures experienced some challenges which included recruitment of participants, response bias from the tools, technical issues and time.

3.6.1 Surveys

The data collection procedure for the survey at Great Stride College involved a structured approach to gather insights on student satisfaction and engagement. Surveys were designed to address research question 1 by assessing learner’s initial attitudes and proficiency with GIS tools. The process began with development of comprehensive survey instruments, which included both quantitative and qualitative questions for example paper based questions. Questionnaires were administered in person over 3 days, from 16 to 18 March 2025, with designated locations such as classrooms and library. The first day involved distributing surveys at the student’s classrooms from 10 am to 12 pm, followed by the library on the second day from 2pm to 4 pm and

concluding with the campus event from 8am to 11 am on the third day collecting responses. After the initial administration, follow up communication was conducted to thank participants and encourage any remaining responses. Data was then securely entered and analysed to identify the trends and insights regarding student's experiences.

3.6.2 Standardized tests

Standardized tests were conducted at Great Stride College under specific conditions to ensure fairness, consistency and reliability in measuring student performance in answering map work tasks. Tests were conducted in a quiet classroom, and the test was a multiple choice out of 20. All necessary materials such as test booklets and question papers and calculators were provided. Students were seated in a manner that prevents cheating often with sufficient space between each participant. Proctors provide clear instructions before the test begins. After the test the invigilator collect all test materials, ensuring that nothing was left behind.

3.7 Data Presentation and Analysis Techniques

The data was analysed both quantitatively and qualitatively. Qualitative data was obtained from the open-ended items in the students and teacher interviews and focus group discussions. The analysis of data was based on the responses collected through questionnaires and focus group. Quantitative data was obtained from closed ended items in the student and teacher instruments. Descriptive statistics would summarise learner's initial attitudes and proficiency levels, addressing research question one and thematic analysis of focus groups would identify recurring themes related to barriers learners face, addressing research question two. Statistical analysis would be conducted using Excel with descriptive statistics summarizing survey responses and

paired t test assessing pre and post intervention differences. Thematic analysis would involve coding transcripts using NVivo software with themes identified through iterative review and refinement. Paired test was chosen to assess statistically significant changes in learner's performance before and after intervention and thematic analysis was selected for its ability to identify recurring patterns and themes in participant's experiences with GIS tools. The data gathered was presented with the aid of tables, graphs and pie charts. Bar graphs would compare pre and post intervention test scores across key variables such as gender and prior GIS experience. Pie charts would display the distribution of responses to survey questions about learner's attitudes towards map work. Content analysis would quantify the frequency of specific attitudes expressed by participants, providing insights into common perceptions of GIS tools and narrative would focus on personal stories shared during interviews, revealing broader themes about technology integration in education. Quantitative findings from surveys and standardized tests would be triangulated with qualitative insights from focus groups and interviews to validate and enrich the study's conclusions. To minimise bias in thematic analysis, multiple researchers would independently code transcripts and discrepancies would be resolved through consensus. Then finally, the findings from quantitative and qualitative data were compared.

3.8 Ethical Considerations

The researcher sought permission from the responsible authority to use the school's staff, students as well as the research site, that was district office and school head. The questionnaire was sent with a cover letter explaining the purpose of the research in more detail. In conducting research on the impact of Geographic Information Systems (GIS) and digital tools on O level learners' map work skills, ethical considerations are of utmost importance. These principles

ensure the integrity of the study and the protection of participants' rights, particularly when working with minors, Bernard (2019). During the research process, the researcher kept time, respect respondent's feedback and decision and treated the information given by the respondents with confidentiality. The participants were not required to put their name on the survey to assure anonymity of the participants. The data and surveys were stored in the home of the researcher.

An important ethical standard was to obtain informed consent from participants. Participants and guardians would be informed about the study's aims, process, potential risks, and benefits before they consent, according to Peck (2018). The informed consent forms were written using plain language to be accessible to the participants and their guardians, and included images to facilitate understanding. Data was stored on a secure, password protected computer and backed up later on a password-encrypted external hard drive that only the researcher could access. While all safe storage options were initially proposed to better comply with data protection laws and regulations, password protected storage was chosen to better protect the privacy of participants. Consent processes would be constructed so that participants understand what they are consenting to, understand their rights, and must be informed that they are free to withdraw from the study at any time with no consequences. Informed consent was particularly critical for this study, since the participants were minors and likely did not fully understand what it meant to take part in research. Although written consent was used for this study, the researcher felt it was important to have a paper record of participant's consent to take part in the study.

Confidentiality and anonymity would be assured as far as possible throughout the data collection process. All data collected would be stripped of personal identifiers; therefore, no responses could be back traced to individuals. Data would be securely stored and secured, with restricted

access to authorised researchers and participants would be comforted that their information would only be used for research purposes and aggregated in any reporting. All data collected would be aggregated data for reporting purposes where individual responses cannot be verified. This study would also have ethical approval from the Institutional Review Board of BUSE before data collection.

Participation in this study was entirely voluntary. This would allow students to have autonomy over their participation without worry of repercussions from BUSE (Creswell, 2019). This empathy toward students aligns with the focus on freewill as part of the research process. The study design would also benefit the researcher's ethics consideration, as it would consider student's well-being throughout the research by minimising risks such as students' discomfort during the assessments or discussions but also by providing a safe space. If any participant showed distress during the data gathering, the researcher would pause the data collection to provide support, and have the option to refer them to available supports nearby if needed.

Finally, the researcher would uphold the credibility and integrity of the study by accurately reporting the findings and not fabricating or falsifying any data. The researcher would disclose conflicts of interest, if any, and would not engage in any dishonest or deceiving acts within my study. In conclusion, adhering to ethical considerations enables the researcher to protect the ethics of all participants while providing valuable insights into the educational effects of GIS and digital tools on map work skills. Adhering to ethical standards would support the reliability and validity of the findings from the study.

3.9 Chapter Summary

This chapter described a research design using mixed methods to study the impact of GIS and digital tools on learner's map work skills. The study used surveys, standardised tests, focus groups, and interviews to collect data, providing both breadth and depth to the data collection, answering the research questions through multiple lenses. The study includes both qualitative and quantitative data collection methods thus showing the design was researched using both quantitative survey and interviews to consider both qualitative and quantitative aspects of the study which sparked inquiry into the research problem. While the mixed method research approach enhanced the study's comprehensiveness there were limitations of small sample size and potential limited generalizability of using self-reported survey data. Ethical considerations around informed consent, confidentiality and voluntary participation helped to ensure the integrity of the study but protecting the rights of participants in research was especially important because of the involvement of minors. The mixed method design addresses a key limitation of earlier studies that used only survey data by combining quantitative measures of performance with qualitative data based on learner's experience of using digital tools bringing a holistic picture of the impact of GIS and digital tools. The next chapter provides an analysis and discussion of the quantitative and qualitative data collected using the surveys, standardized tests, focus groups, and interviews, discussing the trends and themes that are emerging in the data provide ideas about the impact of GIS and digital tools on learner's map work skills and areas of improvement in the geography curriculum.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, INTERPRETATION AND DISCUSSION

4.1 Introduction

This chapter presents analyses and interprets the data collected through questionnaires and interviews at Great Stride College regarding the effect of Geographical Information Systems (GIS) and digital mapping tools on level learner's performance in map work tasks. The analysis is structured to address the research questions established in chapter 1: how GIS enhances spatial literacy and map interpretation, what curricular and infrastructural challenges hinder effective use of these tools and the current level of GIS integration into the curriculum. The analytical framework employs both constructive and experimental learning theories as discussed in chapter 2, to interpret how students construct knowledge through GIS-based experiences and how these experiences translate to improved performance in map work tasks. Following the mixed-methods approach outlined in chapter 3, this chapter integrates quantitative data from student questionnaires with qualitative insights from teacher interviews to provide a comprehensive understanding of the research problem. This chapter is organized into three main sections: first, an analysis of response rate and participant's demographics, second, a detailed presentation and analysis of findings related to each research question, and the third, a discussion of potential solutions to identified challenges. Throughout the analysis, connections are drawn between the empirical findings and the theoretical frameworks established in the literature review, highlighting both consistencies and divergences with previous research.

4.2 Questionnaire and Interviews Response Rate

The study employed purposive sampling to select participants who could provide relevant insights into the use of GIS and digital mapping tools at Great Stride College. From the population of 43 O level geography students and 6 geography teachers, a sample of 15 (35% of the student population) and 4 teachers (67% of geography teaching staff) was selected. The student sample was stratified to include representation across different academic performance levels ensuring diverse perspectives on GIS utility.

Table 4.1: The number of targeted responses in the study and the actual number of respondents.

Item description	Target	Actual	Male	Female	Response rate in %
Students	**15**	**15**	**8**	**7**	**100%**
Teachers	**4**	**4**	**3**	**1**	**100%**
Total	**19**	**19**	**11**	**8**	**100%**

Table 4.1 above presents the targeted and actual response rates for both questionnaires and interviews. All 15 student questionnaires and 4 teacher interviews were successfully completed, yielding a 100% response rate for both instruments. This high response rate strengthens reliability of the findings though it should be noted that the absolute sample size remains relatively small particularly for the teacher group.

The student sample comprised 8 males (53%) and 7 females (47%), with ages ranging fron15-17 years. All students had completed one year of O level geography coursework, ensuring

familiarity with basic map work concepts. The teacher sample included 3 males (75%) and 1 female (25%), with teaching experience ranging from 3 -15 years. Two teachers (50%) had prior training in GIS applications, while other two (50%) had no formal GIS training.

While response rate was optimal, it was important to acknowledge that the findings from this sample cannot be generalized to all secondary schools in Zimbabwe. However, they provide valuable insights into the context of Great Stride College and may be transferable to similar educational settings with comparative resources and curricula.

4.3 Challenges faced by students in using GIS and digital mapping tools.

In a bid to validate data gathered from quantitative findings, the qualitative data was gathered through focus groups discussions. The data obtained from focus group discussion was presented using verbatim, recorded and transcribed. The content analysis was then done.

Table 4.2 showing challenges faced by teachers in using GIS and digital tools.

Challenges	SA%	A%	D%	SD%
a. Time constraints	75	25	0	0
b. Lack of training	75	25	0	0
c. Technical issues	0	50	50	0
d. Limited access to technology	50	25	25	0

e. Over enrolment	**50**	**25**	**25**	**0**

KEY: SA Strongly Agree, A= Agree, D= Disagree, SD = Strongly Disagree

As regards the challenges faced by teachers encounter in their bid to GIS and digital mapping tools effectively, here out of four teachers strongly agreed that lack of training on use of GIS, time constraints, over enrolment and limited access to technology, were chief factors that derailed the pace with which teachers wanted to embrace the use of digital mapping tools and GIS like Google maps and Google Earth in map work tasks. This evidence shows means that lack of enough training of GIS and digital mapping tools, (Williams, 2019), failure by schools to train teachers on the use of digital mapping tools, and failure by schools to adequately avail money to purchase digital tools resources such as computers and software are contributory factors to the reluctance by educators to incorporate GIS in their map work lessons.

Similarly, the educators agreed, though not strongly, that lack of time to use digital tools (25%), technical issues (50%), and limited access to technology (25%) were also detrimental factors that causes teachers to shun using GIS in their teaching of map work. The idea of technological advancements, causing teachers to opt for status quo, are propounded by Gwarinda (2019), who laments that teachers who do not want to give up existing belief and practices, are obstinate when it comes to the use of contemporary teaching approaches like use of GIS. However, another group of teachers disagreed that, technical issues (50%) and limited access to technology (25%). The teachers were quick to refute that they had limited access to technology but they were not knowledgeable on how to use them. This finding goes in tandem with Chitsanga 2019,

who claims that resources could be available in the school, but without equipping educators with requisite skills to manipulate them, they will not attain instructional goals.

4.3.1 Impact of GIS and digital mapping tools on student performance in map work tasks.

4.3.1.1 Teachers views on impact of GIS.

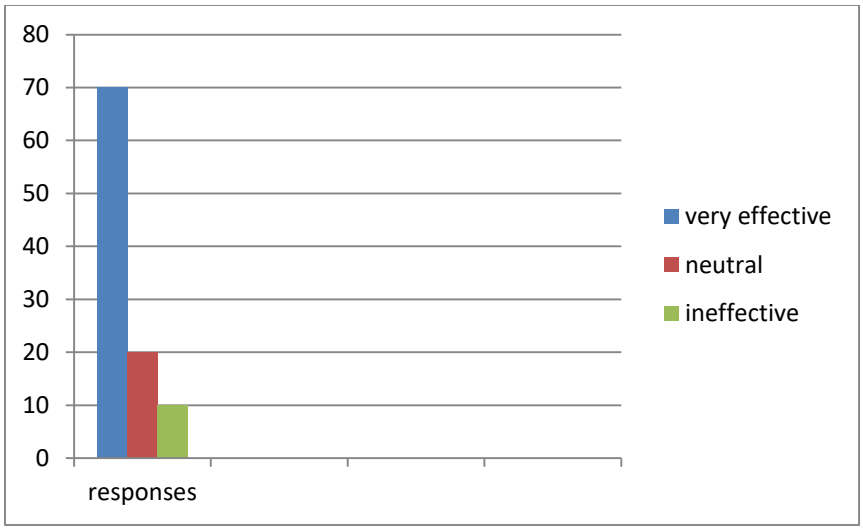
Table 4.3 below shows responses from teachers

Item	Impact of GIS on learners performance	Yes	%	No	%
1	**Digital mapping tools improved student performance**	**4**	**100**	**0**	**0**
2	**Infrastructure limitations hinder learners performance**	**4**	**100**	**0**	**0**
3	**Is there any challenges in teaching map work using GIS and digital mapping tools**	**4**	**100**	**0**	**0**

The findings indicated that 100% of teachers agreed that the use of digital mapping tools and GIS improved learner's performance in map work tasks and infrastructure limitations such as poor internet and software hinder learner's performance in map work tasks. These responses indicate that digital mapping tools have positive impact on learner's performance. The study has also showed that there are challenges faced by teachers in teaching map work using GIS and digital tools. This condition therefore compromises a meaningful learning using digital tools resulting in posing challenges to both teachers and learners.

4.3.1.2 Bar graph showing students views on the Impact of GIS

Fig 4.1 student's views on the impact of GIS



The findings reviewed that a significant majority of students (70%) view GIS as very effective. This indicates a strong positive perception of GIS and digital mapping tools in enhancing their learning experience and understanding of geographical concepts. The high percentage suggests that students recognize the benefits the tools provide in terms of engagement and skill development. About 20% of students expressed a neutral stance on the effectiveness of GIS. This group may have mixed feelings or limited experience with the tools, suggesting that while they acknowledge some value, they might not fully realize the potential impact of GIS on their education. A small minority 10% of students find GIS ineffective. This indicates that some students might have faced challenges or barriers that have led to lack of appreciation for the tools. Understanding their concerns could provide insights into areas needing improvement.

4.4 Learners attitude towards GIS and digital mapping tools.

This section examines student's attitude towards GIS and digital mapping tools, addressing the first research question regarding how these technologies enhance spatial literacy and map interpretation skills. Both quantitative data from student questionnaires and qualitative insights from teacher interviews were analysed to provide an understanding of attitudinal factors.

4.4.1 Teachers observations of students' attitude towards GIS and digital mapping tools

Fig 4.2 Teachers observations on student attitude towards GIS

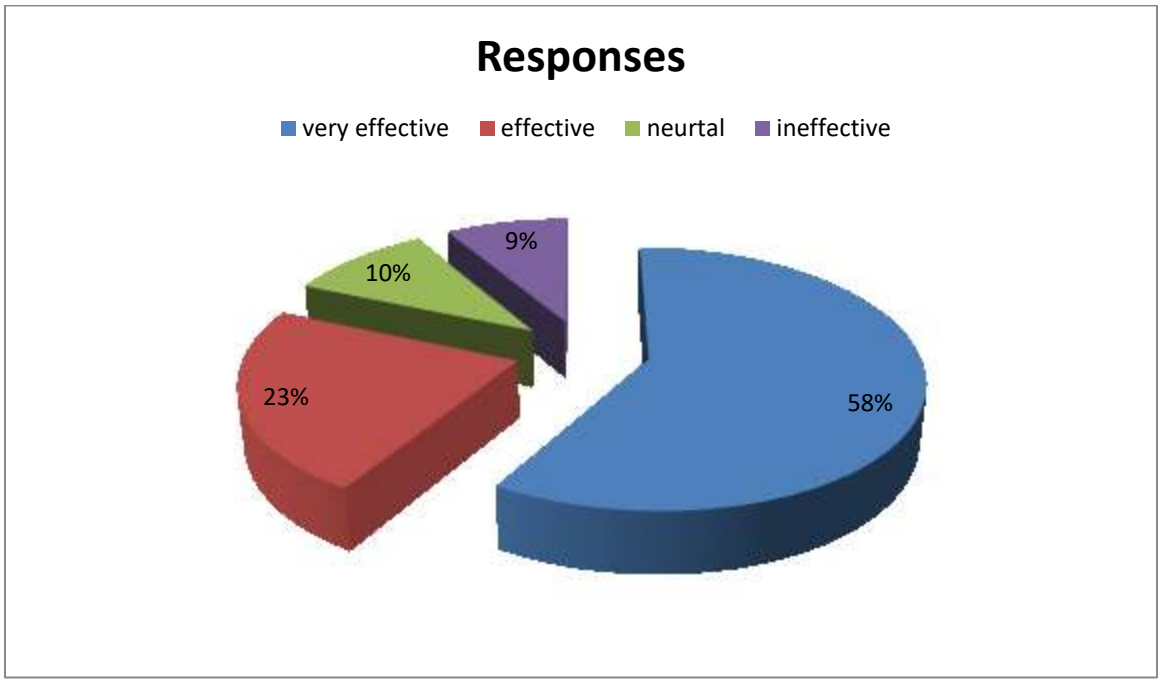


Figure 4.2 presents teachers observations of student's attitude towards GIS and digital mapping tools. The data reveal that a significant majority of students (82%) demonstrated positive attitude towards technologies, with 59% finding them "very effective" and 23% considering them "effective" for map work tasks. This strong positive response suggests that students recognize the value of GIS in developing their spatial literacy skills, supporting the constructivist learning principle that students engage deeply with content when they perceive its relevance and utility.

As one geography teacher explained that students show remarkable enthusiasm when working with digital mapping tools. They approach complex spatial problems with greater confidence and persistence compared to traditional paper exercises. This observation aligns with Madzima (2018) finding that digital tools can transform student engagement with spatial concepts by providing interactive visualization opportunities. The 10% of students who expressed neutral

attitudes towards GIS tools cited technical difficulties or limited access as factors affecting their experience. Some students become frustrated when technical issues interrupt their learning. Those with consistent access and fewer technical problems invariably develop more positive attitude towards technology. This finding highlights the interconnection between attitudes and infrastructure, suggesting that addressing the challenges identified in research question 1.4.2 could further improve student attitudes and consequently, learning outcomes.

The small percentage 8% of students who found GIS tools ineffective warrants further investigation. Teacher interviews suggested that these students had less prior exposure to digital technologies or preferred traditional learning approaches. This finding aligns with Victoria (2019) observation that technology integration must account for diverse learning preferences and digital literacy levels. There was a correlation between positive attitudes and improved performance in map work tasks, while not quantitatively established in this study, was consistently reported in teacher interviews. This relationship merits further investigation in future research to establish the casual mechanisms between attitudinal factors and learning outcomes.

4.4 Possible solutions to the challenges faced by teachers and students.

This section analyses potential solutions to the challenges identified in using GIS and digital mapping tools at Great Stride College, directly addressing research question 1.4.2 regarding curricular and infrastructure barriers. The analysis integrates perspectives from both teachers and students, contextualizing these within relevant literature and theoretical frameworks.

4.5.1 Addressing Technological Infrastructure Challenges.

All four teachers (100%) identified inadequate technological infrastructure as a primary barrier to effective GIS implementation. They proposed several interrelated solutions, with the establishment of a dedicated GIS laboratory emerging as the most as the most comprehensive approach. As one teacher explained that a “dedicated space with appropriate hardware, software and technical support would transform our ability to integrate GIS into regular instruction. Currently we compete for limited computer resources with other departments”. This recommendation aligns with Mukonoweshuro (2020) finding that dedicated technological spaces significantly increase both the frequency and quality of GIS integration in secondary geography education. From an experimental learning perspectives (Kolb, 2020), such dedicated spaces facilitate the hands on engagement essential for developing spatial literacy skills.

The feasibility of this solution depends on several factors, including financial resources, physical space availability and technical support capacity. A phased implementation approach might begin with securing software licenses and upgrading existing computer facilities before establishing a fully dedicated laboratory. This gradual approach would allow for capacity building while working within resource constraints.

4.5.2 Enhancing Teacher and Student Training

Both teachers and students identified training gaps as considerable challenges; they suggested different solutions in terms of scope and approach. Teachers were focused on going professional development and working with experts, while students were concerned with introductory workshops and accessible instructional materials. The teachers' focus on going professional development supports Gwarinda's (2019) observation that an initial professional development session infrequently leads to sustainable change in practice. For example, as Geography Teacher

3 stated we need on going opportunities to develop our skills and partner with GIS professionals. A partnership with Bindura University of Science Education, as an area actively researching and developing GIS in Geography education, could provide our professional development sustainably. As with a constructivist approach to teacher development, teachers can build their knowledge authentically from interaction and collaboration with someone who is expert and experienced (Vygotsky, 2020).

Students' endorsement of introductory workshops and instructional materials reflects the needs to scaffold experiential learning processes when introducing (and developing understanding of) new technologies. This is supported by Thompson's (2019) findings that training in technically-based instruction on GIS requires contextualised training procedures, in addition to inquiry-based learning using GIS. The ideal training model would be comprehensive occurring over a long time-frame, ideally approximating hybridisation of each teachers' and students' preferred approaches, whereby training includes varying levels of introductory training coupled with training in using complex GIS applications. The training process would require clear coordination between the school administration, geography department, and other local geography and education or universities' partners, with distinct timelines built with participants in establishing learning activities, and assessments to evaluate learning effectiveness.

4.5.3 Curriculum Integration Strategies.

The process of considering "How we could meaningfully integrate GIS into an existing syllabus or curriculum" is tricky dichotomy of balancing innovation with what the curriculum dictates, and other students (100%) seemed to agree that the relevant and application of GIS skills in developing projects is the way to go. Madzima (2018) research showed that GIS is more

engaging when it includes cross curricular applications and that pupils engagement and the transfer of skills also improves. The student's suggestion of more assignments or extra-curricular opportunities that centre on GIS also shows their desire for opportunity for practice, and was consistent with the experimental learning theory (Kolb, 2019) emphasis on repetitive application that was required to develop practical skills. A possible strategy for curriculum integration could consider three distinct components, namely: the identification of opportunities in a given curriculum where GIS was an inherent fit and include elements of GIS connecting with existing content, the sequential planning of GIS skills that correlate with the current O level geography syllabus, and finally the tasks or assessments that included a reward for thinking spatially, along with an additional element of GIS. This could be seen as an inclusive approach that meets both the formal curriculum requirements and provides students avenues for additional engagement, which might assist in alleviating the challenge explored by Chitsanga (2019) regarding examination preparation and technological innovation.

100% of teachers suggested that integrating GIS into the curriculum would make learning more relevant and also they suggested that developing interdisciplinary projects using GIS was very crucial and they also suggested that projects that link GIS with other subjects would engage students more in order to overcome curricular integration issues. This finding was in line with (Thompson, 2019) who revealed that teachers recognized the importance of integrating GIS into curriculum, suggesting that this would not only enhance geography education but also promote critical thinking and problem solving skills among students.

4.5 Chapter Summary

This chapter presented and analysed data collected from 15 O level students and 4 geography teachers at Great Stride College regarding the effect of GIS and digital mapping tools on map work performance. The analysis addressed the research three questions that guided this study, yielding several significant findings. Regarding research questions question 1.4.1 on how GIS enhances spatial literacy and map interpretation, the data revealed that students who regularly engage with digital mapping tools demonstrate improved spatial reasoning abilities and greater confidence in approaching complex map work tasks. The positive attitudes expressed by 82% of students suggest that these tools create engaging learning experiences that align with constructivist learning principles discussed in chapter 2. In addressing research question 1.4.2 concerning curricular and infrastructural challenges, the analysis identified three primary barriers: limited access to appropriate technology, insufficient training for both teachers and students and inadequate integration of GIS into the existing curriculum. These challenges reflect broader issues in educational technology integration noted in the literature review, particularly the tension between technological innovation and resource constraints in developing educational contexts. For research question 1.4.3 regarding current level of GIS integration, the findings indicate that integration remains at early stage at Great Stride College, with significant potential for growth. The data suggest that while teachers recognize the value of GIS tools, implementation is inconsistent and often dependent on individual teacher initiative rather than systematic curricular integration. The analysis has several limitations that warrant considerations. The relatively small sample size, particularly teachers, limits generalizability of findings. Additionally, the study relied primarily on self-reported data rather than direct observation of GIS use in classroom settings, which may affect the accuracy of some findings. Despite these limitations, the consistency between the teacher and student perspective and the alignment with

previous research suggest that the findings provide valuable insights into the research questions. Chapter 5 will build on these findings to develop conclusions and recommendations. It will explore the theoretical implications of the identified challenges and proposed solutions, offering strategies for enhancing GIS integration at Great Stride College. Additionally, it will suggest directions for future research to address unanswered questions about the relationship between GIS proficiency and academic performance in geography education.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter concludes the study on the effect of GIS and digital mapping tools on O level learners' performance in map work tasks at Great Stride College. Building on the data analysis and findings presented in Chapter 4, this chapter synthesizes the research outcomes and presents conclusions that directly address the three research questions that guided this investigation: how GIS enhances spatial literacy and map interpretations, what curricular and infrastructural challenges hinder effective use of these tools, and the current level of GIS integration into the curriculum. The chapter begins with a reiteration of the entire study- a rehash of the research problem, methodology and findings. The chapter continues with conclusions, based on the empirical data provided in Chapter 4, organized according to research questions. Following the conclusions, recommendations are provided for school leaders, teachers and curriculum developers. The chapter was rounded out with recommendations for future research that might build upon the current findings and address some unanswered questions in the field of integrating GIS in secondary geography education. Following this outlined structure, the chapter aims to bring closure to the research process while providing a basis for enhancing GIS integration at Great Stride College with an eye to contribute to the broader debate regarding technology in geography education.

5.2 Summary of the study

This study investigated the effect of Geographical Information Systems (GIS) and digital mapping tools on O level learners' performance in map work tasks at Great Stride College, Harare. The research was motivated by the persistent challenges students face in spatial literacy and map interpretation, coupled with growing importance of digital technologies in geography education globally. The study was guided by three research questions focusing on how GIS enhances spatial literacy, what challenges hinder effective implementation and the current level of integration into the curriculum.

The theoretical framework drawn on constructivist and experimental learning theories, as discussed in Chapter 2, which emphasize the importance of active engagement and authentic learning experiences in developing spatial thinking skills. These theories provided lens through which to understand how digital mapping tools might transform traditional geography education by offering interactive learning opportunities.

Methodologically, the study employed a mixed methods approach, collecting both qualitative and quantitative data through questionnaires administered to 15 O level students and interviews conducted with 4 geography teachers. This approach, detailed in Chapter 3, allowed triangulation of data sources and provided an understanding of the research problem from multiple perspectives. The findings, presented in Chapter 4, revealed several key insights. First, students who regularly engaged with GIS tools demonstrated improved spatial reasoning abilities and greater confidence in approaching complex map work tasks. Second, significant infrastructural and curricular challenges were identified, including limited access to appropriate technology, insufficient training for both teachers and students and inadequate integration of GIS into the existing curriculum. Third, the current level of GIS integration at Great Stride College was found

to be at an early stage, with implementation being inconsistent and often dependent on individual teacher initiative rather than systematic curricular integration.

The study's significance lies in its contribution to understanding the challenges and benefits if integrating digital mapping technologies in secondary geography education in Zimbabwe. By identifying the barriers and opportunities, the research provides a foundation of evidence based improvements in teaching practice and curriculum development at Great Stride College and potentially in similar educational contexts.

5.3 Conclusion

Based on the findings presented in Chapter 4, the following conclusions have been drawn in relation to the research questions that guided this study.

5.3.1 Enhancement of Spatial Literacy and Map Interpretation

The evidence of this study demonstrates that GIS and digital mapping tools, when effectively implemented, significantly enhance O level learners' spatial literacy and map interpretation skills at Great Stride College. This conclusion was supported by the findings that 82% of students demonstrated positive attitudes towards these technologies, with 59% finding them very effective for map work tasks (Section 4.3.4). Teacher interviews further corroborated this conclusion, with all four teachers reporting observable improvements in students' ability to analyse and interpret spatial data when using digital tools.

The enhancement of spatial literacy appears to operate through several mechanisms. First, as revealed in Section 4.3.2, digital tools provide visualisation capabilities that make abstract spatial concepts concrete and accessible to learners. Second, the interactive nature of GIS tools allows for experimentation and exploration supporting the constructivist learning principles discussed in

Chapter 2. Third, the technology engages students deeply in the learning process, as evidenced by high percentage of positive attitudes reported in Section 4.3.4.

However, it was important to note that this enhancement is not uniform across all students. The findings in section 4.3.3 indicated that students with prior digital literacy skills benefited readily from GIS integration, suggesting that baseline technological competence may be a mediating factor in the effectiveness of these tools.

5.3.2 Curricular and Infrastructural Challenges

The study identified several curricular and infrastructural challenges that hinder the effective use of GIS and digital mapping tools at Great Stride College. The primary barriers as documented in Section 4.3.1 include limited access to appropriate technology (reported by 75% of teachers), insufficient training for both teachers and students (identified by 100% of teachers) and inadequate integration of GIS into the existing curriculum (noted by all teachers and 87% of students).

The infrastructure challenges are acute, with the findings in Section 4.3.1 revealing that the current computer-to-student ratio was insufficient for effective GIS implementation. These limitation forces students to share resources, reducing hands-on learning opportunities and creating scheduling conflicts that disrupt the learning process.

The curricula challenges are equally significant. As detailed in Section 4.3.2, the current curriculum does not systematically incorporate GIS tools, leaving integration largely to individual teacher initiative. This ad hoc approach results in inconsistent exposure to digital

mapping technologies and missed opportunities for developing progressive spatial throughout the geography curriculum.

5.3.3 Current Level of Integration

The findings from this study indicated that the current level of integration of GIS and digital mapping tools into the curriculum at Great Stride College was at an early and underdeveloped stage. As documented in Section 4.3.2, while there was recognition of the value of these tools among both teachers and students, implementation remains sporadic and unsystematic. The data in Section 4.3.3 revealed that only 35% of map work lessons regularly incorporate digital tools, despite their recognized benefits. This limited integration appears to stem from a combination of the infrastructural and training challenges identified above, as well as from the absence of a strategy for technology integration in the geography curriculum.

It was also clear from the results in 4.4.1 that teachers feel they have very little guidance on how to utilize GIS activities to curricular and assessment demands and expectations - the disconnect causes friction between new learning and exam preparation time which leads to an increased chance of teachers reverting to familiar practices, especially as exam time approaches. In summary, there is strong evidence to suggest that the GIS and digital mapping tools do foster spatial literacy and map interpretation skills for O level students at Great Stride College, there are challenges with infrastructures, pedagogy and appropriate curricula linkage. For GIS to be successfully embedded takes careful consideration to both technology and pedagogy around GIS in secondary geography education.

5.4 Recommendations

Grounded on the conclusions drawn from this study, the following recommendations are proposed for improving the integration and effectiveness of GIS and digital mapping tools at Great Stride College. These recommendations are organized by stakeholder group to facilitate targeted implementation.

5.4.1 Recommendations for School Administration

A. Enhance Technological Infrastructure: The finding that 75% of teachers identified limited access to technology as a significant barrier (Section 4.3.1) suggests an urgent need for infrastructure improvement. It is recommended that the school establish a dedicated GIS laboratory with sufficient computers to maintain a maximum 2:1 student-to-computer ratio. This would address the resource sharing challenges reported by 87% of students in Section 4.3.3.

B. Invest in Software and Training: Based on the finding that all teachers cited insufficient training as a major challenge (Section 4.4.1), the school should allocate resources for both software acquisition and professional development. Specifically, it is recommended that the school:

B.1 Purchase institutional licenses for appropriate GIS software that aligns with O level curriculum requirements

B.2 Establish a regular schedule of teacher training workshops, potentially through partnerships with local universities as suggested by teachers in Section 4.4.1

B.3 Develop a technical support system to address the equipment failures that 100% of students identified as frustrating in Section 4.4.2

C. Implement Assessment and Monitoring: The findings in Section 4.3.3 regarding inconsistent implementation suggest a need for systematic monitoring. It is recommended that

the school develop a structured assessment framework to track both the implementation of GIS tools and their impact on student performance in map work tasks. This should include regular evaluation of both teaching practices and student outcomes.

5.4.2 Recommendations for Geography Teachers

a). **Develop Scaffold Learning Activities**: Based on the finding that 90% of students requested clearer instructional materials (Section 4.4.2), teachers should develop a sequence of GIS activities that build skills incrementally. These should range from basic orientation exercises for beginners to complex spatial analysis tasks for advanced learners.

b). **Create Cross-Curricular Connections**: The suggestion from all the teachers to develop interdisciplinary projects (Section 4.4.1) should be implemented through collaboration with colleagues in other subject areas. Specific projects might include:

i. Environmental monitoring projects with biology

ii. Historical mapping projects with history

iii. Demographic analysis projects with economics

c). **Establish Peer Learning Opportunities**: The finding that students value collaborative learning (Section 4.4.2) suggests that teachers should create structured opportunities for peer teaching and group projects. This could include establishing a "GIS Club" where experienced students can mentor beginners.

5.4.3 Recommendations for Curriculum Development

a). **Systematic Integration of GIS**: Based on the finding that GIS integration is currently ad hoc (Section 4.3.2), it is recommended that a systematic approach be developed to embed digital mapping tools throughout the geography curriculum. This should include:

i. Identifying curriculum points where GIS naturally enhances existing content

ii. Developing a progression of GIS skills that aligns with the O level geography syllabus

iii. Creating assessment tasks that reward spatial thinking and GIS application

b). **Develop Supportive Resources**: The finding that 90% of students requested clearer instructional materials (Section 4.4.2) indicates a need for better resources. It is recommended that teachers collaborate to develop:

i. Step-by-step tutorials for common GIS tasks

ii. Sample projects with exemplars at different performance levels

iii. Troubleshooting guides for common technical issues

c) **Align with Assessment Requirements**: To address the tension between innovation and examination preparation noted in Section 4.3.3, it is recommended that GIS activities be aligned with O level assessment criteria. This should demonstrate to both teachers and students how digital skills contribute to examination success.

These recommendations, derived from the empirical findings of this study, provide a framework for enhancing the integration and effectiveness of GIS and digital mapping tools at Great Stride College. Implementation should be phased, with infrastructure improvements preceding curricular changes to ensure a solid foundation for technological innovation.

5.5 Recommendations for Further Research

This study provided valuable insights into the effect of GIS and digital mapping tools on O level learners at Great Stride College. However, several limitations and unanswered questions suggest directions for future research that would extend and deepen these findings.

5.5.1. Longitudinal Impact Assessment

A limitation of the current study is its cross-sectional design, which captures only a snapshot of GIS implementation and effects. Future research should conduct longitudinal studies tracking students over their entire O level geography course (2 years) to assess how sustained engagement with GIS tools affects spatial literacy development and academic performance over time. Such studies could employ mixed methods, combining quantitative assessments of spatial skills at regular intervals with qualitative tracking of student experiences and attitudes.

5.5.2. Comparative Analysis of Implementation Models

The study identified challenges in GIS implementation but did not compare different implementation approaches. Future research should conduct comparative case studies of schools with varying GIS integration models to identify best practices and success factors. This could include comparing schools with dedicated GIS laboratories versus those with integrated classroom technology, or schools with specialist GIS teachers versus those where all geography teachers incorporate digital tools.

5.5.3. Examination Performance Correlation

While the study suggested a relationship between GIS proficiency and map work skills, it did not establish a direct correlation with examination performance. Future research should investigate the relationship between GIS integration and O level geography examination results, particularly in map work

sections. This could employ a quasi-experimental design comparing examination outcomes between classes with different levels of GIS integration.

5.5.4. Teacher Professional Development Effectiveness

The study identified teacher training as a significant challenge but did not evaluate professional development approaches. Future research should assess the effectiveness of different teacher training models for GIS implementation, comparing outcomes from one-time workshops, ongoing mentoring, university partnerships, and online learning communities. This would help identify the most efficient and effective approaches to building teacher capacity.

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Appendices

RESEARCH INSTRUMENTS

Appendices A

Questionnaire schedule for learners.

My name is Gambiza Energy; I am a student at Bindura University of Science Education pursuing Bachelor of Science Education Honors Degree, Geography. As part of the requirements of the degree, the student is required to carry out a research project and I am undertaking a study titled "**The effect of Geographical Information System and digital mapping tools in O level learner's performance in map work tasks. A case study of Great Stride College**". Your responses will help us understand the effectiveness and challenges of these tools. This study is for academic purpose only. I am hereby kindly asking you to undertake this questionnaire. Be assured that there are no wrong or correct answers. Your responses shall be strictly accorded to the due recognition and confidentiality.

Please do not write your name in this questionnaire

Section A. Demographic data (please tick)

1. Indicate your gender Male { } Female { }
2. Age 10~14 { } 15~18 { }
3. Form 3 { } 4 { }

Section B Experience with GIS and digital tools

1. Do you have regular access to a computer or tablet for school work? Yes { } No { }
2. Have you received formal training on GIS tools? Yes { } No { }
3. How difficult do you find using GIS tools? Very difficult { } moderate { } very easy { }
4. Have you used GIS in your map work tasks? Yes { } No { }
5. If yes, which tools have you used?

   (Select all that apply)

   { } Google maps

{ } ArcGIS

{ } QGIS

{ } Other…… (Name them)

Section C. Impact on Map work tasks

1. How would you rate the effectiveness of GIS tools in improving your map work skills?
   Very Effective **{ }** Effective **{ }** Neutral **{ }** Ineffective **{ }** Very Ineffective **{ }**
2. What features of GIS tools do you find most helpful? (**select all that apply**)
   Layering information { } Data analysis { } Visualization of data { } other { }
3. On a scale from 1 to 5, how comfortable are you using digital tools for map work?
   Very comfortable { } Comfortable { } Neutral { } uncomfortable { } Very uncomfortable { }

Section D Challenges faced

1. **What challenges have you encountered while using GIS or digital tools?** (Select all that apply)
   Lack of training { } Technical issues { } Lack of teacher guidance { } Limited access to technology { } other { }

2. What additional support do you need to use GIS tools effectively?

   ……..

Thank you for participation

Appendix B

Interview guide for teachers

Introduction

My name is Gambiza Energy; I am a student at Bindura University of Science Education pursuing Bachelor of Science Education Honors Degree, Geography. As part of the requirements of the degree, the student is required to carry out a research project and I am undertaking a study titled "**The effect of Geographical Information System and digital tools in O level learner's performancein map work tasks. A, case study of Great Stride College, Harare**. This study is for academic purpose only. Please assist me by responding and discussing the following questions. The interview is going to take approximately 10 minutes. Your responses will remain anonymous and used solely for academic purposes. Are you available to respond to these questions right now?

Section A. Background information

1. Can you introduce yourself? (Name, subject you teach and experience)……
   ……
   ……
2. What is your level of familiarity with GIS and digital tools?.....
   .....
   .....

Section B Integration of GIS and Digital tools.

Objective 1: To assess the practical utility of GIS and digital tools in developing O level learner's ability to apply geographic concepts and solve map work based problems at Great Stride College

Question

Can you describe a specific instance where GIS tools improved students map work performance?……

……

……

How do you assess students map work skills before and after using GIS tools……

……

……

……

Objective 2: To analyze the curricular and infrastructural challenges faced by O level learners in utilizing GIS and related digital tools for map work tasks at Great Stride College.

Question

What infrastructural limitations hinder GIS integration?

……

……

How do you address student's technical difficulties during GIS lessons?

……

……

Objective 3: What is the current level of integration of GIS and related digital tools into the curriculum at Great Stride College?

Question

How is GIS currently incorporated into the curriculum? Are there plans to expand its use? ……

……

What GIS resources and digital tools are currently available at Great Stride College?

……

……

What additional training would help you better integrate GIS into your teaching?

……

……

Thank you for cooperation and your time.

Appendix C
Focus groups discussion questions

1. Describe a time when GIS tools made map work easier or harder for you.
2. How do you think GIS compares to traditional methods for example paper maps for learning geography?
3. How often do you use GIS and digital mapping tools in your geography classes? In what specific map work activities have you used GIS tools?
4. How has using GIS tools affecting your performance in map work assessments? Do you feel more confident in answering map work questions after using digital mapping tools?
5. What difficulties do you face when using GIS software for map work tasks? How do you overcome technical challenges when using digital mapping tools?
6. How does learning map work with GIS compare to traditional paper-based methods? Which method do you prefer for different types of map work tasks and why?

Appendix D Consent form

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE EDUCATION

Consent Form

My name is Gambiza Energy; I am a student at Bindura University of Science Education pursuing Bachelor of Science Honors in Education, Geography. As part of the requirements of the degree, the student is required to carry out a research project and I am undertaking a study titled **'The effect of Geographical Information System and digital mapping tools in O level learner's performance in answering map work tasks. A case study of Great Stride College'.** I am hereby seeking your consent to take a survey and interview for your children and teachers concerning the effect of GIS and digital tools in O level. Be assured that your children's responses shall be strictly accorded the due recognition and confidentiality. All of our reports will be written in a manner that no individual comment can be attributed to a particular person. This interview will take approximately 10 minutes. Do you have any questions before we begin?

Signature

Student .....

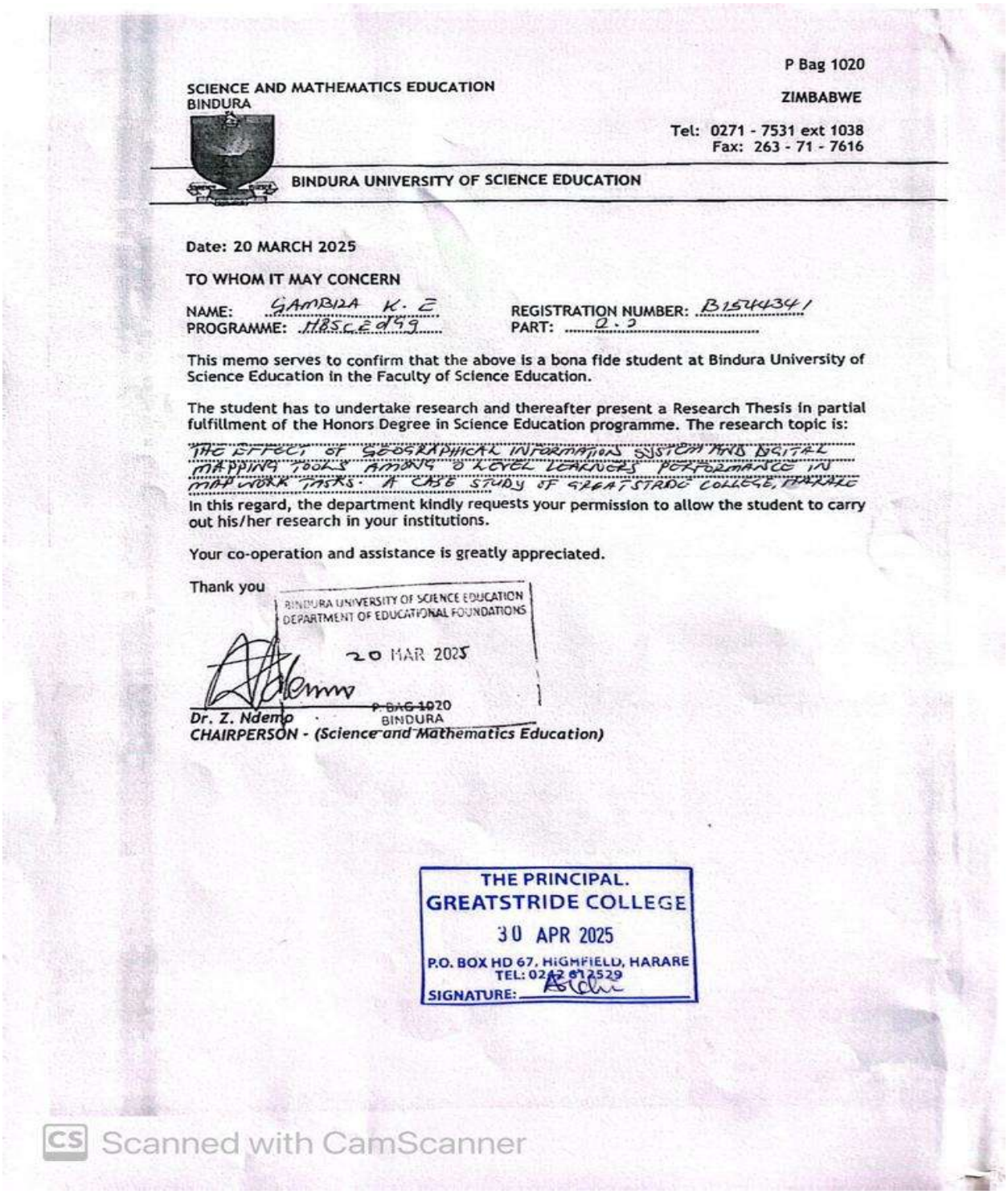
Approval.....

.....

Date .....20/04/25.....

THE PRINCIPAL
GREATSTRIDE COLLEGE
30 APR 2025
P.O. BOX HD 67, HIGHFIELD, HARARE
TEL: 0342 612529
SIGNATURE:

Appendix F . Authorization letter



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BINDURA UNIVERSITY OF SCIENCE EDUCATION

Date: 20 MARCH 2025

TO WHOM IT MAY CONCERN

NAME: GAMBIZA K. E
REGISTRATION NUMBER: B1544341
PROGRAMME: HBSCEdSg
PART: 4.2

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 Thesis in partial fulfillment of the Honors Degree in Science Education programme. The research topic is:

THE EFFECT OF GEOGRAPHICAL INFORMATION SYSTEM AND DIGITAL MAPPING TOOLS AMONG O LEVEL LEARNERS PERFORMANCE IN MAP WORK TASKS. A CASE STUDY OF GREATSTRIDE COLLEGE, HARARE

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

Your co-operation and assistance is greatly appreciated.

Thank you

BINDURA UNIVERSITY OF SCIENCE EDUCATION
DEPARTMENT OF EDUCATIONAL FOUNDATIONS
20 MAR 2025
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BINDURA

Dr. Z. Ndemo
CHAIRPERSON - (Science and Mathematics Education)

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