ENHANCING LEARNERS' PERFORMANCE IN GEOGRAPHIC INFORMATION SYSTEM: A CASE STUDY OF SELECTED SCHOOLS IN SEKHUKHUNE EAST DISTRICT

by

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Thesis submitted in fulfilment of the requirements for the Degree of

DOCTOR OF EDUCATION IN CURRICULUM STUDIES

in the

DEPARTMENT OF CURRICULUM STUDIES

FACULTY OF HUMANITIES, SOCIAL SCIENCES AND EDUCATION

UNIVERSITY OF VENDA

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2025

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DECLARATION

I, Makgobelele Samson Mabitsela, declares that **Enhancing Learners' Performance in Geographic Information: A Case Study of Selected Schools in Sekhukhune East District** is my own unaided work and has not been previously submitted in any form whatsoever, by myself or someone else, to this university or any other educational institution for any degree or examination purposes. All the resources that I have used or quoted have been acknowledged and indicated by means of a complete list of references.



15/02/2025

MAKGOBELELE SAMSON MABITSELA **DATE**

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DEDICATION

This dissertation is dedicated to my late parents, Mr Masellane Jan and Mrs Leseilane Annah Mabitsela, who raised, nurtured and guided me through my studies, my wife Mashego, my sons, Mabitsela Wesley, Mabitsela Welshman and Mabitsela Seane Mpho and my siblings for support and encouragement during my studies. Above all, the Almighty God who serves as a torch bearer to reach my study destination, I am indebted to you.

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ACKNOWLEDGEMENTS

- I would like to thank:
- The Almighty God, for giving me the wisdom, strength, courage, light, endurance and tolerance to navigate through the process for everything so that I get the desired outcomes for the study. You were my Sheppard throughout my studies. Glory be to God.

- Dr RM Makhwathana, my supervisor, for her valuable information, critical comments, suggestions and encouragement throughout the research process. Through your undivided attention and support, this research project became a reality. Thank you for your commitment and dedication to my studies.

- Professor TS Mashau, my co-supervisor, it has been a great honor and privilege to learn from the leading minds like you for the insight and knowledge that you installed in me. Thank you for unwavering support, guidance, and motivation that you showed throughout the supervisor-supervisee relationship, which made me rise above and many academic challenges.

- The Department of Education Limpopo Province, Sekhukhune East District Director, the Circuit Managers, principals of the sampled schools, curriculum advisors, Geography teachers and their learners for taking the precious time to share information and participate in the study.

- My family members, in general, for the love, passion, and perseverance. This project belongs to us.

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ABSTRACT

The learners' failure rate in Further Education and Training is attributed to different factors, including but not limited to the introduction of the Geographical Information System, changes in assessment, redeployment of teachers, and insufficient knowledge of the content by teachers. The purpose of the study was to explore the strategies to enhance the learners' performance in the Geographical Information System in the Further Education and Training Phase in Sekhukhune East District. The study adopted an interpretivist paradigm and a qualitative research design using case studies, and data were collected through observation, interviews, and document analysis. The population of the study included all learners, Geography curriculum advisors, and all teachers of Geography in Sekhukhune East District. A purposive sample, which consisted of 15 respondents, namely, three curriculum advisors, six learners doing Geography and six Geography teachers, was used. The study adopted qualitative research methods and case study research design. The findings indicated how a particular strategy impacts learners' performance, such as The Dinaledi Project, incubation, twinning of schools, training teachers on using ICT to enhance GIS lessons, and workshops and seminars for Geography subject advisors and teachers on GIS teaching. Based on the study findings, the researcher recommends that the Department of Basic Education and its stakeholders should collaborate with the private sector so that schools can benefit from GIS data and GIS awareness campaigns and access data easily. Schools should also purchase GIS-compliant Learner Teacher Support Materials to provide guidance and explain GIS easily.

Keywords: Geographic Information System, Information and Communication Technology, Intervention Strategy, Learner Performance, Curriculum Advisors

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LIST OF ACRONYMS

FET	Further Education and Training
GIS	Geographical Information System
ICT	Information and Communication Technology
NCS	National Curriculum Statement
DBE	Department of Basic Education
USA	United States of America
RSA	Republic of South Africa
NSC	National Senior Certificate
LTSM	Learner Teacher Support Material
UK	United Kingdom
SASA	South African Schools Act
APIP	Academic Performance Improvement Plan
IGIT	Information Geographic Information Teaching
CMI	Computer Mediated Classroom Teaching
TPK	Technological Pedagogical Knowledge
PK	Pedagogical Knowledge
TCK	Technological Content Knowledge
CK	Content Knowledge
TPACK	Technological Pedagogical Content Knowledge
NFT	Not Fully Trained
TA	Thematic Analysis
UHDC	University Higher Degree Committee
ATPS	Annual Teaching Plans
PGCE	Post Graduate Certificate in Education

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CHAPTER 1

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 INTRODUCTION

This chapter deals with the background of the study, the statement of the problem, and the purpose of the study, followed by the research questions, the definition of key concepts, the research design, and the methodology. It further discusses the significance of the study, the literature review, the theoretical framework, the delimitation of the study, the chapter outline of the study, and finally ends with the conclusion.

1.2 BACKGROUNDS TO THE STUDY

A frequent change of curriculum in the education system of South Africa has brought about changes in the structure and content of some subjects (Ornstein & Hunkins, 2017:45). The introduction of the Geographical Information System (GIS), a section in the Geography subject where teachers use computers and other software to teach GIS effectively has also brought a degree of fear and anxiety to those who are illiterate (Mkhongi & Musakwa, 2020:4). For the teachers to teach Geographical Information System effectively, they need to be computer literate. The learner's performance in GIS can be enhanced through the adoption of Tecnological Pedagogical Content Knowledge (TPACK) as pointed out by Mishra and Koehler (2006:111) and Teacher Practice Allocation Resource Committee (TPRAC) as stated by Santos and Castro (2021:2). Consequently, the adoption of learner centered strategies such as the group work, collaboration and projects can enhance performance of learners in GIS (Santos & Castro, 2021:2). The responsibility of teaching Geographical Information System rests firmly with the Geography teachers. However, the challenges of teaching Geographical Information Systems in Grade 12 are a matter of great concern, as indicated by the National Senior Certificate Diagnostic Reports (2020:103) for the past five years; learners continue to struggle with data analysis, buffering, data integration, and so forth. Despite the

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importance of the Geographical Information System in South Africa, the analysis done and shown in the NCS Examination Diagnostic Report for Geography (2020:103) reflects low learners' performance in Geographical Information System (See Table 1.1 below).

Table 1.1: **Average Percentage Performance of GIS from 2018 – 2022**
Adapted from: NSC Examination Diagnostic Report for GIS, DBE, 2020

YEAR	PERCENTAGE
2018	48%
2019	50,1%
2020	46,7%
2021	53,3%
2022	56,2%

Mkhongi and Musakwa (2020:5) assert that learners find Geographical Information Systems difficult, which results in dismally low learners' performance in Geography, in general, and Geographical Information Systems, in particular. According to Joseph (2018:45), learners' low performance in Geographical Information System is caused by factors such as a lack of content knowledge and misunderstanding of Geographical Information System terminology, teachers' lack of contents mastery, as well as teachers' deficiency in computer skills and other software because GIS needs teachers who are computer literate in order to teach learners more effectively (Felix, 2021:49). In remote rural schools, where there is no electricity, Geographical Information System is more difficult to teach, resulting in a low pass rate among Geography learners.

Chew (2018:78) states that in Malaysia, the difficulties of integrating Geographical Information Systems are caused by issues such as, among others, a lack of computers at schools, a lack of time to prepare laboratories, and insufficient funds to purchase other software. According to Felix (2021:3), in the United States of America (USA), Geographical Information System technology has transformed the Geography curriculum,

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bringing computers to the desktops; as such, teachers have to use computers to prepare and present GIS lessons. Degirmenci (2018:191) opined that in countries such as Turkey, the causes of learners' low performance with respect to GIS are, among others, teachers not being competent in using GIS, and poor infrastructure for the use of GIS, to mention a few.

In Nigeria, as pointed out by a number of authors, such as Joseph (2018:2), the learners' low pass rate in GIS is attributed to factors such as inadequate funding, low teacher quality, and poor infrastructure. Sumari (2018:2) posits that in African countries such as Tanzania, the challenges faced by GIS teachers are the lack of power, internet connection, and school curriculum and insufficient resources, and these are nonetheless contributing to low learner performance. Fadeel (2018:56) asserts that in Egypt, the challenges associated with the implementation of GIS in most schools are caused by a number of factors, including a lack of knowledge and skills, inadequate funding, challenges related to data and challenges related to procedures.

In South Africa, Malaysia and the USA, inadequate computers and other software make it difficult for teachers teaching Geographical Information Systems to prepare and present their lessons, contributing to the low pass rate in Geographical Information Systems (Mcube, 2018:53; Felix, 2021; Chew, 2018).

My 35 years as a Geography teacher make me claim that government-related factors, teacher-learner-related factors contribute to learners' low performance in the Geographical Information System. Learners' low and declining performance in the Geographical Information System as a result of poor teaching methods and other related factors motivated the undertaking of this study.

1.3 STATEMENT OF THE PROBLEM

Although Geography teachers have received some form of training in the teaching of GIS, the learners' performance is low (Leepo, 2015:54). The National Senior Certificate Examiners' Diagnostic for Geography 2020 provides enough evidence for these realities.

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The learners' performance in the Geographical Information System is dismally low, with an average pass percentage of 40.9% nationally (DBE, 2020). These results are, nonetheless, low and disturbing. The National Diagnostic Report (2020-2022) also revealed that learners performed poorly in the GIS section dealing with data interpretation, and the majority of learners do not bother to answer such questions. The learners' low performance in GIS and how their academic performance can be enhanced matter greatly in this study. According to Leepo (2015:30), the major problems in schools with respect to performance are influenced by teaching and learning strategies. Additionally, poor assessment methods in GIS and a lack of GIS resources, such as Information and Communication Technologies in South Africa, also prompted this study. The teachers also experienced challenges in teaching GIS due to a lack of data, poor power supply, insufficient infrastructure and laboratories and so forth for GIS (Degirmenci, 2021:5).

The importance of the Geographical Information System in the Geography curriculum cannot be overemphasised. Thus, this research identified the Geographical Information System as a challenge to learners' performance due to its consistently low performance. Filgona, Sababa and Filgona (2018:2) opined that the traditional teacher-centred teaching methods that lead learners to be inactive are outdated, and challenges experienced by learners, such as a lack of computer skills, are a matter of great concern. Therefore, this study sought to explore the strategies that could enhance learners' performance in the Geographical Information System.

1.4 THE PURPOSE OF THE STUDY

The purpose of the study was to explore the strategies to enhance learners' performance in Geographic Information Systems.

To achieve this purpose, the following objectives were developed:

- To determine the causes of low performance in the Geographical Information System
- To investigate the challenges experienced by teachers when teaching Geographical Information Systems.

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- To explore suitable strategies that can be adopted to enhance performance in the Geographical Information System.
- To identify the Information and Communication Technology materials that can be adopted to enhance the performance of learners in Geographic Information Systems.

1.5 THE RESEARCH QUESTIONS

The main research question is: Which strategies could enhance learners' performance in the Geographical Information System in Sekhukhune East District, Limpopo Province? To answer this question, the following subsidiary questions were developed:

- What are the causes of low performance in the Geographical Information Systems?
- Which challenges do you experience in the Geographical Information Systems?
- Which intervention strategies could be adopted to enhance learners' performance in the Geographical Information System?
- Which Information and Communication Technology materials could be adopted to enhance the performance of learners in the Geographical Information Systems?

1.6 SIGNIFICANCE OF THE STUDY

This study may lead to developing strategies and mechanisms to enhance learners' performance in Geographical Information Systems. Furthermore, it is hoped that the study will alert the Department of Basic Education to consult teachers as partners in education when introducing new curricula. The study might also assist policymakers in involving all stakeholders in making policies for various government departments, in general, and the Department of Basic Education, in particular. The study may aid researchers in conducting further investigations into introducing new sections in different subjects, such as GIS. The involvement of teachers in all matters relating to the curriculum, as well as changes in the curriculum's design, should be reinforced by this

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study. The broader society will benefit from this study, as it will highlight issues, such as curriculum changes, that will affect its members and their children. Finally, the study will highlight and alert the Department of Basic Education about the problem teachers face in teaching GIS and assist academics in improving educational practices by doing more research with respect to GIS and its implementation.

1.7 LITERATURE REVIEW AND THE THEORETICAL FRAMEWORK

This section discusses the literature related to the causes of learners ' failure rates in GIS, challenges, strategies that could be explored to enhance learners' performance in Geographical Information Systems, as well as the impact of Information and Communication Technology (ICT) on learners' performance in GIS, and the theoretical framework that underpinned the study.

1.7.1 The Causes of the Learners' Low Performance in the Geographical Information System

According to Ornstein and Hunkins (2017:71), some of the causes of learners' low performance in GIS in the Further Education and Training Phase are insufficient supplies of Learner and Teacher Support Materials that deal specifically and adequately with the GIS section of Geography. According to Leepo (2015), teachers' attitudes towards change contribute to the high failure rate in the GIS section of Geography. Some of the teachers fear and resist changes, and instead of adapting and coping with changes, they teach by applying old methods that are teacher-centred and emphasise rote learning. GIS requires teachers who are computer literate, and this also contributes to the high failure rate in the GIS section of Geography in most schools (Ali, 2020:24).

Chew (2018) argues that teachers' lack of training and the teaching of the GIS section in Geography and other software when teaching, preparing, and presenting their lessons, especially on subjects that require the use of technologies such as the GIS section of Geography, is contributing to poor learner performance in that particular section. Teachers must be trained before they are expected to implement any new sections in

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their subjects; for example, in Geography (the GIS section), training in computers and other software is necessary. The GIS section has been introduced without consulting the affected educators. In addition to this, teachers are not well-trained in using GIS, as this is dominated by computer-related information, such as modelling, buffering, data validation, spatial resolution, data capturing, and so forth.

According to Joseph (2018:58), it seems that the majority of teachers teaching Geography have never been trained on how to teach GIS effectively and lack the knowledge, skills, and expertise, as well as funds to purchase enough software. The lack of electricity in some schools with respect to the GIS section, which requires them to be computer and other software literate in order to teach effectively, also contributes to the high failure rate. Research also indicates that low learners' performance is caused by a variety of factors, including the motivation (intrinsic) of the learners, the learners' attitudes towards learning, family background, educator competence and profile, as well as the climate and the culture of the school (Leepo, 2015:87). Felix (2018:98) state that the quality of any education system is determined by the availability of resources such as computers and other software and the availability of competent and qualified educators, and if there is a lack of qualified and competent educators, this will influence learners' performance. Teachers who are competent and qualified, who have confidence, and who have passion and dedication towards the profession generally influence the outcomes in one way or another.

Chisholm (2007:94), as quoted by Leepo (2015:58), observed that learners' low performance in most subjects may be due to the teachers' inability to make extra effort in the classroom, and this is often one of the problems and concerns of the present time. A teacher with inadequate content knowledge often creates content gaps when teaching a particular grade. For example, if a particular teacher has inadequate knowledge in Grade eight, learners promoted to Grade nine will obviously have a content gap, and this is one of the contributing factors to low learner performance rates. Leepo (2015:55) observed that the content in rural and urban schools is different, implying that rural schools perform lower than affluent urban schools, and this is attributed to the adequate teachers versus the inadequate content knowledge of the rural teachers.

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As the Geographical Information System is offered through theory and practice, certain aspects should have been considered when introducing it:

- The training of the teachers with respect to the use of computers and other software in teaching the Geographical Information System,
- The government's provision of Information and Communication Technology in schools, and electricity
- The involvement of the teachers in matters related to curriculum changes and implementation, as well as the teachers' attitudes towards change, is important.

1.7.2 Challenges that are Experienced by Learners when Studying GIS

Researchers such as Seremet (2016:65) pointed out that GIS, as a section in Geography, needs critical, analytical, and interpretive skills, and all these skills necessitate learners to think abstractly. Chew (2018:50) echoed the same sentiment when he pointed out that most learners do not perform well in the GIS section in Geography because they have insufficient skills for data interpretation, data analysis, data manipulation, and so forth. Geography GIS relates to subjects such as Physical Science, Geo-informatics, Mathematics, Mathematical Literacy, and Environmental Sciences, and these serve as the challenges for Geography learners, in general, and GIS, in particular.

The National Examination Diagnostic Report for Geography (2020:71) pointed out that the majority of learners performed poorly in GIS, as it deals with data interpretation, and the majority of the learners do not bother themselves to answer such questions. It is further stated in the same report that common errors and misinterpretations were in data interpretation, data analysis, data manipulation, and data identification. Consequently, the researchers who researched GIS observed that learners were also challenged by Question 3.3 in the GIS question paper, which assessed data identification, data classification, and data interpretation, and, as such, learners' performance in this question was low and disturbing. The majority of learners are unable to apply and link the knowledge gained in the theory part of Geography to the GIS question paper. The

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Mapwork section also serves as a challenge for the same learners, as they also perform poorly in that section (Diagnostic Report, 2020:18).

The National Senior Certificate Diagnostic Report for Geography (2021:47) further revealed that the majority of teachers are not fully trained on how to teach GIS effectively, and this prompted learners to perform dismally low in GIS. Chew (2018:47) concurred that the causes of low performance in GIS are a lack of computer skills, training, and computer-related software, and issues related to internet infrastructure in most schools, especially in remote rural areas.

1.7.3 Challenges Experienced by Teachers when Teaching GIS

In South Africa, the Geography Information System was first introduced in 2006 at secondary school level from Grades ten to twelve (Clarence-Fincham, 2016:97). The authors further assert that Geography teachers teaching GIS in schools in developing and developed countries are facing some challenges, including:

- Lack of/or inadequate computer equipment and high cost of hardware and GIS software.
- Lack of teacher training and curriculum material.
- Systematic use involves the use of innovation in teaching.
- Lack of time required to educate teachers about GIS.
- Insufficient coverage of GIS in secondary school curriculum.

In South Africa, teachers, like learners, experience the following school-related challenges when teaching learners: poor teachers, poor learners' attitudes, inadequate Learning and Teaching Support Material (LTSM), overcrowding in classrooms (Makhwathana, Mulaudzi & Muthambi, 2021), the language of teaching and learning, absenteeism, frequently changed Geography curriculum, and teachers' qualifications and training that do not correspond with what they teach.

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1.7.4 Strategies to Enhance the Pass Rate of GIS in the Further Education and Training Band

The use of Information and Communication Technology (ICT) in education has greatly increased learners' performance in some subjects. In subjects such as Geography, where GIS is taught, the use of ICT requires computers and other software to manipulate, collect, and interpret data (Felix, 2018:32). Therefore, GIS teachers need to be computer literate.

The use of diagnostic reports, as pointed out by Leepo (2015:70), could also improve the performance, enhancing learner performance. In addition to diagnostic reports, item and error analysis is applied to enhance the performance of learners with respect to GIS. It is through item and error analysis that the teacher can identify errors and incorrect actions, describe how to correct mistakes or improve on the mistakes or the appropriate action, and move swiftly to craft the improvement plan (Blu Dot, 2018:65). The primary purpose of item and error analysis is to investigate the errors that learners make or have a negative impact on the process of learning. It informs the teachers about what learners have already mastered and what they are struggling with, and it also helps teachers improve their methodologies and employ differentiated learning according to learners' cognitive levels.

According to Mkhongi and Muaskwa (2020:77), the capacity-building workshops for teachers, the involvement of curriculum advisors and chief markers of Geography, the delivery of extra lessons by qualified and competent personnel, benchmarking, the development of an academic improvement plan and curriculum management as well as guidance and counselling and training on the effective use of technology, could also be considered strategies to enhance the pass rate of GIS in the Further Education and Training Phase. In addition to the creation of GIS resources, the creation of human resource capacity, being supportive of leaders in GIS education, and building capacity within the Geography community, researchers and teachers could also enhance learners' performance in GIS. In the case of educators, competency and confidence in the use of geospatial data can contribute to a healthy and conducive Geography environment,

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which, in turn, enhances the learners' performance; hence, GIS requires teachers who are competent in the use of ICT.

In African countries such as Zambia, Kenya and Nigeria, the use of traditional textbooks is being replaced with computer programmes on the desktop, which means that less skilled educators could be reduced (Blue Dot, 2018:80). In countries such as the USA, the United Kingdom, and Malaysia, the use of computers and other software enhanced learners' performance with respect to GIS. In those countries, teachers are well-trained on how to use Information and Communication Technology to teach GIS more effectively, and this contributes to good learners' performance in Geography (Joseph, 2018:73).

According to Mkhongi and Musakwa (2020:1), GIS Days organised by the Department of Education, where learners doing Geography are taught and workshopped about GIS, is one of the best strategies for enhancing the learners' performance in GIS, including the use of geo-special technologies to assist students with comprehending Geography. Given the resource shortage that burdens the South African education system, Interactive GIS Tutoring (IGIST) and GIS camps can be adopted as strategies for enhancing GIS education and GIS proficiency for both students and educators. Other strategies include geo browsers, human capacity development, software support, and GIS science. Blu Tot (2018:40) suggests paper-based GIS and continuous research as some strategies for enhancing GIS. Tan and Chen (2015:40) further emphasised that the prosperous introduction of GIS education requires an integrated and multi-tiered response from educators, schools, and greater stakeholders in the public and private sectors.

Adeleke and Awolowo (2018:128) argue that the use of computer-mediated instruction as an engendering motivating force that enables the learners to progress at their own pace is the best strategy for learners' performance in GIS. The Computer-Mediated Classroom Instruction (CMI) is an offshoot of Information and Communication Technology that is used to uplift the standard of GIS education, and also engage students in GIS to develop information and media literacy, preparing them well for the digital age. Sing et al. (2016:6) affirm that the use of Information and Communication Technology in supporting and transforming teaching for enhancing students' achievements in

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Geography is the best practice for learners' performance in GIS. In addition, the ICT engaged the students' participation in the learning process by encouraging them to gather necessary and important information, search for a solution to the problem, and attain the right solution.

According to Mkhongi (2020:40), to address the low learners' performance in GIS initiatives from the private sector, tertiary institutions, and public institutions include but are not limited to workshops on GIS education, GIS exhibitions where learners and educators can be exposed to GIS material and information in the field, seminars and training session for both learners, educators and the Geography curriculum advisors.

Kerski (2021:10) affirms that training programmes on GIS are of cardinal importance to performance because it is through these programmes that teachers are equipped with expertise and technological skills on how to teach GIS in the classroom more effectively. Kerski (2021:1) further states that the training of teachers on how to teach GIS and technical support in schools is a significant factor in promoting learners' performance in GIS.

Although many teachers teaching Geography are veterans, the number of years of teaching at institutions of higher learning with respect to GIS could also enhance the learners' performance. This means that teachers need to specialise in GIS to gain deeper insight, which can contribute to the improvement of learners' performance in GIS. The increase in awareness of GIS technology and other related technologies, such as the Global Positioning System (GPS) and remote sensing, gives teachers a platform that can promote learning performance. Currently, teaching in the Geography classroom in the FET Phase in South African schools emphasises teaching about GIS rather than teaching with GIS. This indicates that teaching with GIS as a strategy could also enhance the learners' performance in schools doing Geography as a subject (Leepo, 2015:48).

According to Innes (2018:101), the strategies that could be explored to enhance learners' performance in GIS are the preparation and provisioning of teachers to develop geo-spatial competence, and this can be accomplished by providing required resources, such

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as geo-technology from maps on paper to maps on screen. Leepo (2015:14) concurs that the use of sophisticated technology is seen as an opportunity for Geography teachers to enhance learning, and the availability of software and hardware that is available and used with confidence by GIS teachers to enhance learning also contributes to learners' performance.

In South Africa, Innes (2012:104) reports that the use of cooperative maps by learners in their activities and self-instruction has been evaluated as a method of enhancing learners' performance. Also, teaching about GIS and Geography concepts using GIS improves the learners' performance in GIS. Equally important for the learners' performance, they should be encouraged to undertake GIS-enabled investigations with local relevance in their home area (Kerski, 2021:105).

According to Leepo (2015:15), to bridge the gap in GIS contact knowledge in the curriculum, local training for teachers on contact should be done. In this instance, Geography curriculum advisors should arrange eight to ten hours of training on GIS at the beginning of each year to deal with the challenges in GIS. The use of diagnosed reports of Geography issued by the Department of Education also shed light on those sections of GIS in which the learners performed poorly in Grade 12 external examinations. In addition, the local training of Geography teachers and cluster GIS meetings in the afternoon can improve learners' performance in Geography, in general, and GIS, in particular.

In the meetings, the Geography curriculum advisors select lead teachers for the curriculum while facilitating the same discussion of GIS topics. In some instances, the delivery of supplementary tuition, for example, school holiday classes, afternoon and morning extra lessons, and the creation of learning centres could also serve to improve learners' performance in GIS. Additionally, the adoption of matric camps where GIS specialists are involved, learners are given extra time, and they are taught by competent and qualified personnel, which also indicates that performance could be improved. Normally, in these camps, learners are taken to spend two to three weeks in a selected area before the commencement of Grade 12 end-of-year examinations, taught by a

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specialist for revision. In these camps, learners are taught through previous question papers and any other relevant work that could prepare them for the final examination (Leepo, 2015:100).

Leepo (2015:94) further states that well-performing schools often accommodate learners from underperforming schools. This process is called incubation. In this regard, learners from underperforming schools are taught by teachers in the hosting school. In some instances, teachers from well-performing schools are asked to teach in the underperforming schools, just as the curriculum advisors often do. The twinning of schools involves the provision of teaching aids and other resources to under-resourced schools. The advantages of twinning are as follows (Leepo, 2015:44):

- It helps in capacity building as the sharing of vital information and skill transfer takes place in the process.
- It helps in the identification of best practices since it creates opportunities for the identification of new ideas, approaches, techniques, and methods of teaching.
- It further helps to add value, improve the quality of learning outcomes, and increase organisational effectiveness.
- It promotes networking and the mobility of learners and teachers.

1.8 THE IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) ON THE LEARNERS' PERFORMANCE IN GIS

Although Geography teachers have been trained on how to prepare and present lessons using textbooks, nowadays, technology has been integrated into Geography teaching, and this has become complex and difficult for some teachers. The teachers' lack of confidence and knowledge about technology makes it difficult for them to teach more effectively. GIS can be effectively understood and taught when the necessary ICT resources, such as computers with internet access, are available. Information and Communication Technology in GIS changes the roles of teachers and students, communication, and methods of teaching and learning (Kerski, 2021:10).

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Adeleke and Awolowo (2018:115) state that today`s students are not the same as those of the past; they have been born into a digital age, where technology forms an integral part of their lives. In relation to GIS, Information and Technology have an impact on learning and teaching. Mishra and Koehler (2006:110) further state that to integrate ICT in the Geography classroom effectively, there has to be technological knowledge, content knowledge, and pedagogical knowledge. The TPACK model is a good sign of teaching with technology. It requires an understanding of the representation of concepts using technologies, pedagogical knowledge that uses technologies in a constructive way to teach knowledge, what makes concepts difficult or easy to learn, and how technology can redress some problems students face (See the TPACK model below that gives a summary of the key concepts).

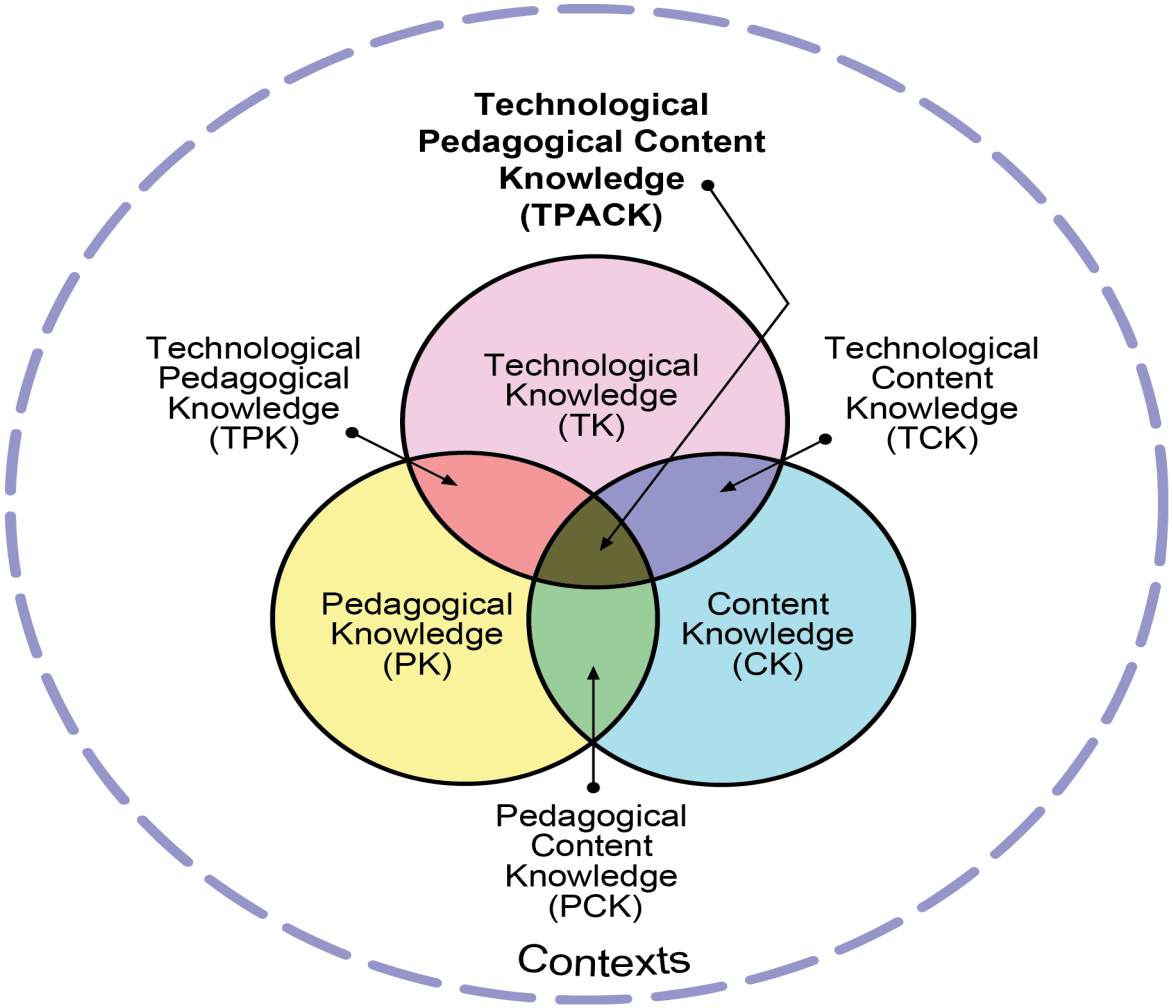


Figure 1.1: The TPACK model (Source: Mishra & Koehler, 2006)

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Shulman (2004:40) concurred that the TPACK model is the cornerstone of the ability of the teacher to teach effectively with the implementation of ICT in the teaching of Geography. In teaching GIS, the teachers' ability to implement ICT in the classroom is central to the improvement of learners' performance in Geography. Shulman (2004:50) observed that the integration of ICT in the teaching of Geography, as well as the pedagogical practices, enhances learners' performance in GIS.

1.8.1 Theoretical Framework

The study adopted the social constructivism theory developed by Lev Vygotsky, which is based on the principle that learning is a social activity in which meaning is constructed through social interaction (Mathew, 2018:2). While behaviourists such as Skinner, Watson and Jane argue that knowledge is passively transmitted in the minds of learners, social constructivists such as Bruner, Olorode and Jimoh, as quoted Kanno (2018:76), argue that knowledge is actively constructed by the learners on their own rather than passively absorbed, and it is essentially dependent on the standpoint from which the learners absorb it. According to Omwirhen (2018:43), social constructivism is based on the principle that knowledge is actively constructed, learning is presented as a process of discovery, and the role of the teacher is to facilitate discovery by providing the necessary resources and by guiding the learners, as they attempt to assimilate new knowledge to old knowledge and modify the old to accommodate the new. According to Akpan et al. (2020:50), social constructivism is a learning theory based on the principle that language and culture are the frameworks through which humans experience, communicate, and understand reality. In social constructivist theory, learning concepts are transmitted through language, interpreted, and understood through experience and interaction within a cultural setting.

In teaching GIS, this can be demonstrated when learners are working in groups to identify raster and vector data on the map. Dorgu (2015:7) states that social constructivism is also called collaborative learning because it is based on interaction, discussion, and sharing among the students. This teaching strategy allows for a range of interaction methods, such as total class discussion, small group discussion, or students working in

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pairs on a given assignment or project. The underlying factor in this theory is that learners work in groups, sharing ideas, brainstorming, trying to discover cause and effect, finding answers to problems, or just creating something new to add to existing knowledge. Kapur (2018:23) observed that in social constructivism, the construction of knowledge takes place in various ways and at different locations, which include group discussion, teamwork, and social media forums, interaction in educational institutions, religious places, and marketplaces.

When teachers teach GIS, such as data interpretation, manipulation, and capturing, learners are given instructions to work on their own to construct information using their computers and other software. This is learning by doing, and this is active participation, which constitutes social constructivism. Social constructivism theory recognises the importance of pre-knowledge of learners and independent problem solving; views assessment as an integral part of learning, whereby learners can gauge and judge their own progress, and believes that instruction is learner-centred, which encourages learners to analyze, interpret, and predict the information (Kanno, 2018:36).

Learning is a collaborative process. Zhou and Brown (2015:70) further distinguished two levels of development, namely, the level of actual development, which is the level that the learner has already reached, and the level at which a learner can solve problems independently. The level of potential development (zone of proximal development) is the level of development that the learner can reach under the guidance of the teacher or in collaboration with peers.

According to Kanno (2018) and Omwhirhen (2018:81), in teaching GIS, social constructivism theory is demonstrated when learners are given data to classify as vector or raster, and they work collaboratively to complete an assignment, which will enable them to solve problems independently. Through this collaboration, learners develop teamwork skills and see individual learning as essentially related to the success of group learning. Collaborative learning is a process of peer interaction that is mediated and structured by the teacher. In teaching GIS, collaboration as a constructivist strategy is demonstrated when the teacher gives learners some concepts, such as buffering, data

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manipulation, and remote sensing, to discuss in groups and then give answers on their own.

According to Kanno (2018:203), interpret social constructivism in education is a model of practice that encourages active participation by the students to create meaning and knowledge independently, while the teacher serves as the facilitator, consultant, and problem solver, scaffolding some of the activities. Enabling the learners to produce geographical information requires skills and knowledge coupled with GIS training. The GIS section in Geography requires learners to interpret data, analyse information, and this will only be possible if the learners, on their own, create meaning, knowledge, and skills while the teacher facilitates the learning process.

Kanno (2018) and Omwhirhen (2018:74) define the social constructivist approach to learning theory as the active construction of new knowledge based on the learners' prior experience. Koohang (2009:97) states the following: The key idea is that students actively construct their own knowledge: the mind of the student mediates input from the outside world to determine what the student will learn. Learning is an active mental process, not a passive reception of teaching.

The aims of the social constructivist approach are they provide experience with knowledge; they provide experience in and appreciation of multiple perspectives. Besides, the learners play a central role in mediating and controlling learning; knowledge construction and not reproduction is emphasized, and teachers serve in the role of guides, coaches, tutors, and facilitators. Moreover, scaffolding is facilitated to help students perform just beyond the limits of their ability, and it is authentic and interwoven with teaching (Koohang, 2009:73).

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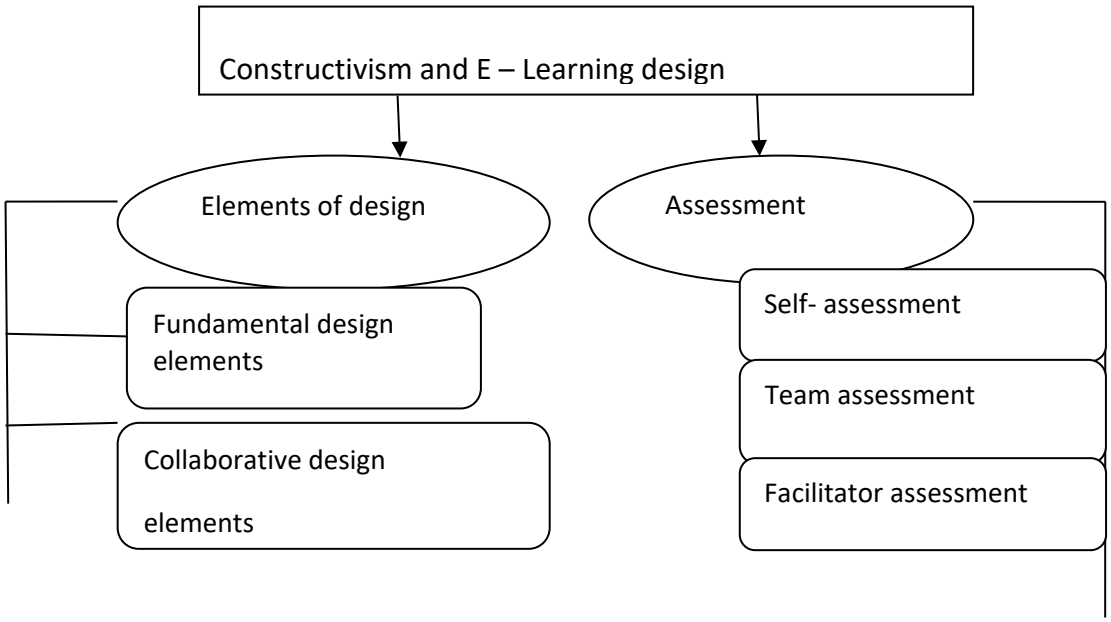


Figure 1.2: Eléments of Social Constructivism Theory (Source: Koohang, 2009:4)

The above model of social constructivism indicates that most of the activities and assignments that the learners do should be learner-centred to encourage them to actively construct new knowledge and to work collaboratively. The social constructivist approach uses self-assessment by the learners as individuals, and learners are encouraged to assess each other's work as a team. Finally, facilitator assessment is also of paramount importance in the social constructivist approach, where the facilitator assesses each learner's work.

Kanno (2018:206) argues that social constructivist theory "is a learner-centred approach in education." Learners learn how to think because they are involved in the real world, where activities take place. The teacher is the facilitator who learns together with the learners in class. In GIS technology, learners work as individuals or groups and manipulate data from software, as they understand it, to produce their own, and they can also manipulate the software to produce whatever is spatially related to the data that is available or accessible.

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In social constructivism, the learning of GIS is an active process because learners are active during the learning process, where they use tools at their disposal to generate information, solve problems, and think critically on their own. According to Omwirhiren (2018:34), social constructivism recognises the social aspect of learning and the use of conversation, interaction with others, and the application of knowledge as essential aspects of learning and the means of achieving learning objectives. In teaching and learning about GIS, this can be demonstrated when learners use language to communicate about the uses of GIS. In terms of teaching, as pointed out by Dorgu (2015:43), the social constructivism theory uses the discussion method that utilises guided interaction to highlight a particular subject matter. In addition, group activities, project-based learning, and the jigsaw as a guided discovery are utilised. In teaching about GIS, this is applicable when learners are divided into groups when identifying polygon features on the map. According to Kanno (2018:14), the importance of social constructivism is that it encourages active participation by the students; it encourages the development of skills. It develops critical thinking and problem-solving capacity and promotes individual and cooperative learning in the classroom. It encourages students to develop and use their own initiatives, stimulates interest and aids retention, and promotes team spirit among the students as they work in groups.

Learners are not passive recipients of knowledge and information but are always involved; they participate actively as individuals and as a group to construct knowledge and meaning (Koohang, 2009:38). The cooperation between the learners to manipulate, collect and interpret data in a GIS lesson means that cooperative learning could contribute to the improvement of Geography in general and GIS in particular; hence, its focus is on collective responsibility among the learners. This cooperation will help learners develop some skills such as problem-solving, data collection, critical thinking, socialisation, and independent analytical skills (Koohang, 2009:95).

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1.9 DEFINITION OF CONCEPTS

1.9.1 Geography

The word Geography has been derived from the Greek words “geo”, which means earth, and “graphen”, which means to “describe” or “write.” Geography is the study of the location and distribution of living things, the earth’s features, and natural resources (Wilmot, 2018:2). In this study, the concept of Geography refers to a subject that is offered in the South African school curriculum from Grades 10 to 12.

1.9.2 Geographical Information System (GIS)

According to Ali (2020:3), a Geographical Information System (GIS) is a system of computers, software, hardware, and data personnel that makes it possible to enter, manipulate, analyse, and present data and information that is tied to a location on the earth’s surface. In this study, GIS refers to a section in Geography that is taught predominantly using computers and theory-based models from Grades 10 to 12 in the Further Education and Training Phase.

1.9.3 Information and Communication Technology (ICT)

According to Ratheeswari (2018:1), ICT stands for Information and Communication Technologies. It refers to technologies that provide access to information through telecommunications. It includes the internet, wireless networks, cell phones, and other communication medium. In this study, Information and Communication Technology refers to the use of communication networks to enhance learners’ performance, for example, remote sensing, global positioning system, aerial and satellite images, and so forth.

1.9.4 Curriculum Advisors

to the Department of Education (2016:17), curriculum advisors are specialist office-based educators in the district or circuit office whose function is to facilitate curriculum

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implementation and improve the environment and the process of learning and teaching by visiting schools and consulting with teachers. In this study, curriculum advisors refer to the subject specialists who are office–based and are responsible for advising Geography educators about Geography.

1.9.5 Intervention Strategies

This refers to the staff action that outlines methods, cues, programmes, or tasks that enable the child to successfully complete a specific goal (Department of Basic Education, 2016:21). In this study, intervention strategies are strategies designed to address gaps in students' learning by focusing on specific areas of need.

1.9.6 Research Paradigm

Maree (2019:385) states that a paradigm serves as a lens or organising principle through which reality is interpreted. The research paradigms are categorised into positivism,anti-positivism, critical or transformative, interpretivism, and pragmatic paradigms (MacMillian & Schumacher, 2010:50). In this study, the researcher adopted the interpretivism paradigm. The interpretivism paradigm is based on the assumptions that human life can only be understood from within, which people construct the social world by sharing meanings, experiences and how they interact or relate to one another; social life is distinctively human, meaning reality is not objectively determined but socially constructed (Maree, 2019: 20). This paradigm related to this study, in which Geography teachers and curriculum advisors (people in this study) shared their experiences and how they interacted and related to one another regarding the teaching and learning of Geography. Thus, this study sought to understand the phenomenon in their own settings, for example, by studying the teachers in their own workplaces or classrooms; hence, multiple realities were socially constructed.

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1.10 RESEARCH METHODOLOGY

1.10.1 Research Design

Maree (2019:97) defines a research design as a "set of guidelines and instructions to be followed in addressing the research problem. The purpose of the research design is to specify a plan for generating the empirical evidence that will be used to answer the research question (MacMillian & Schumacher, 2010:20). The research designs are classified into four major categories: grounded theory, ethnography, phenomenology, and case study research design. This study adopted a qualitative case study research design. This case study design indicates which individuals will be studied and where, when, and under which circumstances they will be studied. Maree (2019:91) affirms that a case study is an intensive, holistic description and analysis of a single entity, phenomenon, or social unit. In this study, the researcher was interested in the meanings, understanding, and interpretation of the research problem relating to developing strategies to improve learners' use of the Geographical Information System. The researcher opted for a qualitative case study research design to gain an in-depth understanding of the situation surrounding the development of strategies that Geography subject advisors could explore to improve the learners' performance in Geographical Information Systems in the Further Education and Training Phase.

1.10.2 Methodology

MacMillan and Schumacher (2010:43) define research methodology as the different techniques, methods, and procedures that are used in the process of implementing the research design. According to Rehman (2016:24), research methods are classified into three categories: qualitative methods, quantitative methods, and mixed methods. In this study, qualitative research methods were used, where data collection methods, including document analysis, interviews, and observation, were used to probe deeper into the responses given by the interviewees and untangle complex topics (Cresswell, 2013:54).

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1.10.3 Sampling and Sampling Procedure

This section involves the selection of the population, the determination of the sampling procedure, and the samples. Purposeful sampling was used because the participants in purposeful samples represent the characteristics that are of interest to the research at hand (MacMillian & Schumacher, 2010:74). The authors state that in purposeful samples, the researcher makes judgements regarding which participants should be selected. The researcher worked with curriculum advisors and Geography teachers, selected on the basis that the teachers were directly involved in the teaching of Geographical Information Systems, whereas curriculum advisors served as advisors and support to teachers. Thus, the researcher was interested in exploring strategies to enhance learners' performance in the Geographical Information System.

The study used a non-probability sampling strategy, such as purposeful sampling, to select the participants for the study. Purposeful sampling is commonly used in educational settings (Maree, 2019:73). Purposeful sampling was adopted because the participants had representative characteristics that were of interest to the research topic at hand.

1.10.4 Population

A population is a group of elements or cases, whether individuals, objects, or events, that conform to a specific area and to which we intend to generalise the results of the research (MacMillan & Schumacher, 2010:129). The population of this study included all Geography curriculum advisors, all Geography teachers, and all learners doing Geography in the Sekhukhune District.

1.10.5 Sample

According to Maree (2019:91), a sample is defined as a group of subjects from whom data are collected, often representative of a specific population. A sample is taken to determine the accuracy of the research and to collect rich data. According to MacMillan

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and Schumacher (2010:64) and Maree (2019:214), sampling methods are classified into two groups: probability samples, such as simple random sampling, systematic sampling, stratified sampling, and cluster sampling, and non-probability sampling, such as convenience sampling, quota sampling, snowball sampling, and purposeful sampling.

A purposive sample of fifteen respondents consisted of three Geography curriculum advisors, six senior Geography teachers in three circuits, as well as six Grade 12 Geography learners from six schools in the three circuits, and was selected purposively. Hence, the sample consisted of fifteen respondents.

1.11 DATA COLLECTION STRATEGIES

In this study, qualitative data were collected through semi-structured interviews, observation, and document analysis.

1.11.1 Interviews

According to Maree (2019:35), an interview is a two-way conversation in which the interviewer asks the participants questions to collect data and learn about ideas, beliefs, views, opinions, and behaviour of the participants. Interviews were applied to this study because they helped the researcher obtain rich descriptive data needed in understanding the participants' construction of knowledge and social reality. The researcher took one month in the field to conduct the interviews with the selected participants, and these were recorded for purposes of transcription, review, and additional questions at the end of the interview. Permission from the participants was obtained before the commencement of the interviews (Creswell, 2013:212).

1.11.2 Observation

According to Macmillan and Schumacher (2010:43), observation is a systematic process of recording the behavioural patterns of the participants, objects, and occurrences without necessarily questioning or communicating with them. This was done in the field for a

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prolonged period. Maree (2019:56) opined that the advantages of observation are that it enables the researcher to hear, see, and experience reality as the participants do.

1.11.3 Documents Analysis

Documents include but are not limited to mark schedules, diagnostic reports, and books that are textual and are used to gather data during the research process (Maree, 2019:100). Documents such as diagnostic reports, item and error analysis, and mark schedules were used to gather information on the questions on the Geographical Information System, on which most learners performed poorly. Using different methods to collect data ensured that sufficient information was obtained, which gave a clear picture of the state of the performance of the Geographical Information System in schools in Sekhukhune East District, Limpopo Province.

1.12 DATA ANALYSIS

A coding system is created when the respondents' information and questions are translated and then divided into categories. On the interview transcripts, all quotes that seemed to contain information that answered the research questions were highlighted (Kali, 2005:23). Codes for different categories were created (for example, HFRs for the High Failure Rate and NFT for Not Fully Trained). In this study, data were analysed inductively based on an interpretive philosophy aimed at examining meaningful symbolic content and allowing the research findings to emerge from themes. In this content, data analysis was applied to this study by interviewing Geography teachers about their experience of teaching GIS.

In this study, the Thematic Analysis (TA) method of data analysis was applied. Thematic analysis is a common form of qualitative research that emphasises identifying and interpreting patterns of meaning or themes within the qualitative data. It is also used to address different research questions. According to Braun and Clarke (2006:79), the objectives of thematic analysis are to produce key themes pertaining to the understanding of the participants, and due to its flexibility, thematic analysis is used in case studies.

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Furthermore, thematic analysis provides core skills that are useful for conducting many kinds of analysis. The researchercoded the data using content analysis to look for specific words for which themes can be identified (Maree, 2019:68). Furthermore, data analysis aims to pick up problems in the data collection methods as well as identify possible challenges in the process of analysis (Kali, 2005:24). It was applicable to this study because the collected data, including interviews and transcripts, formed the basis for the study. Again, the collected data were coded, and the researcher aimed to qualify and then interpret and make inferences in order to address the research question.

1.13 DELIMITATION OF THE STUDY

The proposed study was conducted in only six schools from Moroke, Mmashadi, and Driekop Circuits in Sekhukhune East, Limpopo Province.

1.14 ETHICAL CONSIDERATIONS

Maree (2019:30) states that "…anyone involved in the research needs to be aware of the general agreement about what is proper and improper in scientific research".

Firstly, the researcher applied for ethics clearance from the University Research Ethics Committee (UHDC) before commencing the research.

This study involved humans, and therefore, the following ethical principles were adhered to:

1.14.1 Informed Consent and Voluntary Participation

This means the participants were given consent forms to sign to show their willingness to participate in the research process before it commenced. Consequently, the participants were informed that their participation was voluntary, and if they wished, they could withdraw from participating in the research without any consequences.

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1.14.2 Protection from Harm

The researcher should take reasonable measures to ensure that participants are free from harm. Still, if this is not possible, the researcher must inform the participants of the risks (MacMillan & Schumacher, 2010:34).

1.14.3 Privacy, Confidentiality, and Anonymity

Any information obtained during the research process was treated as private and confidential. At the same time, anonymity was maintained throughout the research process, unless the participant consented to the information being divulged. The participants involved were assured of not being identifiable in the final version.

1.15 OUTLINE OF THE STUDY

- **Chapter1**: **Introduction**

This chapter provides a general study overview, including an introduction and rationale. This chapter contains research problems, research questions, the purpose of the research, and the definition of concepts.

- **Chapter 2: Theoretical Framework**

This chapter outlines the theoretical framework for the study by providing a theory that underpins the study.

- **Chapter 3: Literature Review**

This chapter describes and discusses the literature that underpins the study. Consequently, the literature defines concepts that will also be paramount in the discussion of the literature review.

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- **Chapter 4: Research Methodology**

The third chapter describes the research progress in-depth, including the research paradigm design and data collection methods to be followed in the study.

- **Chapter 5: Data Analysis and Interpretation**

Chapter 5 presents the raw data, an analysis of the data, and the study's findings. Results were presented using a case study design.

- **Chapter 6: Summary, Limitations, Recommendations, and Suggestions for Further Study**

In this chapter, the researcher summarised the study's results and presented conclusions drawn from the study. Limitations and recommendations for additional research were also discussed.

1.16 CONCLUSION

In this chapter, the researcher provided the introduction and background of the study, the purpose of the study, the research questions, and the problem statement. The key concepts underpinning the study were defined, and all the study parameters were highlighted, including the research methodology and the research design. The next chapter presents the theoretical framework on which the study is based and its relevance to teaching and learning of Geography GIS.

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CHAPTER 2

THEORETICAL FRAMEWORK

2.1 INTRODUCTION

This chapter provides an in-depth discussion of the theoretical framework of social constructivism and an in-depth literature review on enhancing learners' performance in GIS. This chapter also endeavours to discuss the relevance of Social Constructivism theory and the TPRAC Model in relation to the teaching of Geography GIS.

1.2 THEORETICAL FRAMEWORK: SOCIAL CONSTRUCTIVISM AND TPRAC MODEL

The Social Constructivism theory informed the study in question. The proponents of this theory, such as Lev Vygotsky, as quoted by Kupur (2018:23), state that teaching involves the interaction of teachers, learners, and the community. This social constructivism theory was adopted to prompt an understanding of theories and concepts relevant to the challenges that teachers experience when teaching GIS and the challenges learners experience when studying and learning GIS.

The social constructivist theory is learner-centred, which implies that teachers, learners, and the community interact, but most of the activities are done by the learners. In South Africa, the model of Outcome-Based Education (OBE) was adopted as a way of encouraging a learner-centred approach whereby learners act as active participants in the learning process (Vakalisa et al., 2011:34). Kanno (2018:19) opines that learning is the process by which learners are integrated into knowledge. Akpan et al. (2020:54) concur that language and culture are frameworks through which humans experience, communicate, and understand reality, and concepts are transmitted through community cultural settings.

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The social constructivism theory acknowledges social collectivity's role in learning and development. Liu and Mathew (2005:394) stated that social collectivity in learning means that cooperation and collaboration encourage learners to participate actively in the learning process. For example, learners can work in groups to discuss and identify vectors and attribute data using the topographical map in a GIS lesson. Using team games and a cooperative learning approach whereby learners work in groups using Information and Communication Technology, such as computers and software to manipulate data, enhances learners' performance in GIS. In applying social constructivism theory in the classroom, teachers can divide learners into mixed, moderate, and slight ability groups, which encourages mutual independence and collaboration. At the same time, individual attention and accountability are afforded (Dorgu, 2015:44).

Vygotsky, quoted by Liu and Mathew (2005:399), asserts that in schools, three components are always dynamic: the environment, the learners, and the teachers. For example, throughout the GIS lessons, learners should be given satellite images such as MODIS, TerraSAR, and bands such as Landsat to emphasise vegetation and to detect fire. In doing so, learners can explore environmental features such as fire, which is possible through the intervention of the teacher. In such situations, teachers will be helping the learners to explore the environment around them, which means that the learners are active participants in the learning process, able to use the tools at their disposal to generate information, solve problems and think critically (Dorgu, 2015:44). Onwirhiren (2015:36) affirms that social constructivism is based on the principle that knowledge is co-constructed in the social environment where there are social interactions, and people use their language as a tool to gather information. In teaching GIS, teachers can use simulations that require learners to observe various concepts and phenomena. That means learners test their knowledge and understanding against that of the facilitator. According to Kanno (2018:19), the use of language among the learners stimulates cooperation while working in the GIS environment, and this interaction and discussion among the learners stimulate socialisation and their cultural influence on learners, and therefore, this could help learners to deduce concepts. Social constructivism is based on the conviction that learners should be guided to build meaningful knowledge important

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to their lives. The teacher's role is to scaffold and facilitate the learning lesson (Kanno, 2018:19).

According to Kanno (2018:45) and Omhirhiren (2018:47), the clear focus of social constructivism is that learning is based on how learners learn rather than what they learn. In doing so, learners develop some skills such as analytical, problem-solving, and socialisation skills, which are more important than the content learners learn. The social constructivist theories also believe that teachers should assess learners continuously, meaning they should assess learners throughout the year.

In principle, social constructivism is based on the notion that learners build new knowledge from the foundation of the knowledge they have gained previously. In Geographical Information Systems, in Grade twelve, learners are expected to have prior knowledge of GIS in Grades ten and eleven, such as data manipulation, buffering, vector and attribute data, to mention a few. This also requires learners to have prior knowledge about how to buffer different layers on a paper, which, likewise, implies identifying and differentiating the types of data on the topographical map as well as the orthophoto.

The Geographical Information System started in Grade ten; therefore, it is of paramount importance for the learners to have prior knowledge about GIS (BluDoT, 2018:50). Learners, for example, should have prior knowledge of how to differentiate between vectors and attribute data and be able to identify those features on the map. Furthermore, learners should differentiate between cultivated lands and rivers using the topographical map instead of making mistakes in differentiating the features using the orthophoto map, which is not visible for identifying features. The foundation of knowledge is given by the teachers to learners to develop them academically. The theory of social constructivism believes that new knowledge is built on what the learners bring into the classroom, that is, what they already know (Brown, 2015:70).

This social constructivism theory becomes relevant in teaching and learning GIS because the same learners possess prior knowledge of GIS from Grades ten and eleven, respectively. Social constructivism is built on the premise that every learner builds his or

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her views and opinions instead of serving as a receiver of knowledge and ideas from the teacher. GIS teaching embraces the use of the social constructivist style of teaching and learning since learners work collaboratively to identify features on the topographical maps and orthophoto (Kim, 2018:54). BluDoT (2018:62) affirms that in the classroom, social constructivist teaching emphasises a change in teaching approaches that is from passive recipients of knowledge by the learners to interactive and active participation where learners can create their knowledge. Social constructivism is related to their study, as some of the challenges of learning and teaching GIS in Grade 12 learners are related to the social environment where learners come, and the researcher wanted to come up with teaching methods or strategies that can counter these challenges.

One of the strategies that can be explored to solve these challenges is the collaboration strategy. According to Vygotsky, as cited by Kanno (2018:15), in collaboration, the role of the teacher is to observe, guide, coach, scaffold, monitor, and facilitate the learning process, which empowers the learners to take full responsibility and ownership of the learning progression as part of the collaboration. This, on its own, as pointed out by Kanno (2018:16), is one of the teaching strategies that can be applied to reduce the learners' failure rate of Grade 12 Geography GIS.

According to Okoro et al. (2020:49), social constructivism is based on the principle that learning takes place in different ways at different levels. The authors add that social constructivism occurs when learners, through active participation, construct or create basic knowledge by themselves through enquiry and discovery. This focuses on interaction, collaboration, and group work for effective learning.

Deeba (2021:2) affirms that social constructivism is a collaborative learning approach that emphasises student involvement, discussion, and knowledge exchange. In Geography, this is relevant when learners are divided into groups, given a map to interpret information, share ideas, and come to a common conclusion based on different views.

Okoro et al. (2020:2) further state that in social constructivism theory, language and culture are the framework through which humans experience, communicate, and

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understand reality. According to Vygotsky, as quoted by Okoro et al. (2020:2) and Deeba (2021:2), learning concepts is transmitted by means of language, interpreted, and understood by experience and interactions within the cultural setting.

BluDoT (2018:56) posits that social constructivism puts a great emphasis on social learning when children's understanding is shaped not only through adaptive encounters with the physical world but also through interaction between people in relation to the world that is not merely physical and apprehended by the senses, but cultural, meaningful and significant, and made so primarily by language. Kanno (2018:70) posits that social constructivism recognises the social aspect of learning and the use of conversation, interaction with others, and the application of knowledge as an experiential aspect of learning and means to achieve learning objectives.

Social constructivism is about collaborative learning because it is based on interactions, discussion, and sharing among students. This teaching strategy allows for a range of groupings and interactive methods (Okoro et al., 2020:3). The authors further add that in social constructivism, collaborative learning includes total discussion, small group discussion, or students working in pairs on a given project or assignment.

Kapur (2018:45) observed that the social construction of knowledge takes place in various ways and in different locations. It could be achieved through discussion, teamwork, or any instructional interaction in an educational or training institution, on social media, in religious settings, and in marketplaces. As students interact with people, material and immaterial environments, they gain understanding and gather the experience thatis needed to live successful and functional lives (Kapur, 2018:48). In Geography, GIS social constructivism becomes relevant because learners are given topographical and orthophotomaps to identify, interpret and manipulate data in groups and this encourage teamwork, collaboration and discussion sessions.

According to Deeba (2021:5), social constructivism is characterised by learners constructing knowledge, knowledge being acquired through experience, and learning being a social activity; all parts of the learners are interconnected. Aljohani (2017:14)

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observes that learning occurs as a result of learners ' real-life experiences, and consequently, learning is a social, interpersonal connection and communication with community members that helps to instill learning in people.

Rannikmae et al. (2020:15) assert that social constructivism is characterised by inclusive and equitable learning communities. In essence, individual needs for knowledge, information, and awareness and acknowledgement of the social character of learning point to learning communities that are inclusive and fair. Dewey and Piaget emphasised that learning community inclusiveness aids learners in developing a feeling of dignity and their ideas, thoughts, conceptions, options, viewpoints, and way of life. Institutions should respect one's uniqueness and offer a foundation for people to construct reality from their unique perspectives (Rannikmae et al., 2020:25).

Kanno (2018:42) posits that social constructivist learning happens most effectively through social interaction and collaboration with others, where individuals actively construct knowledge by building upon the existing understanding through discussion, shared experiences, and peer feedback. Kanno (2018:43) further states that the guiding principle of social constructivism is that knowledge is constructed through human activity and interaction.

According to Theys (2018:1), constructivism sees the world and what we can know about the world as socially constructed; in social constructivism, structure and agency are mutually constructed. Sarba (2020:2) argues that in social constructivism, people acquire knowledge and information based on their experiences, and the learner needs autonomy in the classroom. Omwirhiren (2018:20) contends that social constructivism as a learning theory encourages active participation by the learners as teams or groups engaging in activities. The authors further state that group work, teamwork, and collaboration are central to the social constructivism of knowledge by the learners.

In Geography, lessons on GIS learners can work in groups discussing the difference between vector and rector data. Consequently, the social construction of knowledge can

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be demonstrated in a GIS lesson when learners work in groups and collaborate to identify points, lines, and polygon features on topographical and orthophotography maps.

Kanno (2018:66) concurs that social constructivism is a collaborative form of learning based on interaction, collaboration, discussion, and knowledge sharing among the learners as active participants in the learning environment. BluDoT (2018:50) observed that it is through social constructivism of knowledge that learners become active participants in knowledge constructions based on prior knowledge, while the teacher serves to scaffold some of the activities. Ncube (2018:8) posits that the social constructivist approach to the teaching of Geography places student engagement with the materials being learnt in the centre of the learning process. As such, the efficacy of the teacher's pedagogy is measured or evaluated according to the extent to which learners are engaged in the learning process and, therefore, able to understand the subject matter (Ncube, 2018:8). The author further states that in the case of Geography, learners need to be actively involved in the learning process as opposed to the traditional lecture method, where the learners are just passive, expecting the teacher to spoon-feed them with knowledge.

Kanno (2018) and Onwirhiren (2018) affirm that the social construction of knowledge requires learners to work in groups and collaborate to solve Geographical problems. For example, when the teacher divides the learners into groups and discusses the data interpretation and manipulation in GIS, this demonstrates the social construction of knowledge; hence, learners in groups work together to achieve common objectives (Kanno, 2018:40).

According to Okoro et al. (2020:49), social constructivism de-emphasises teacher monotony in the classroom but encourages active interaction among the learners, the teacher, and other components of the learning-teaching process. It also concretises the learning and knowledge by making students retain the facts they discover and construct by themselves; then there, they are told by the teacher, among other benefits (Okoro et al., 2020:1).

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Deeba (2021:406) argues that in social constructivism, children's understanding is influenced by their adaptive encounter with the physical world and interpersonal exchanges about cultural, meaningful, and relevant ability. The author adds that in social constructivism, dialogue, collaboration, and information use are crucial components of learning and strategies for achieving learning goals. Dorgu (2015), Kanno (2018), and Kapur (2018) affirm that in social constructivism, knowledge develops as a result of interaction among the learners and other components of the learning process and is not an individual possession but a shared experience. Okoro et al. (2020:51) suggest that social constructivism could be applied in the classroom using such instructional methods as research case studies, projects, problem-solving-based learning, brainstorming, collaborative learning, group work, guided discovery learning, and simulation, among others.

Deeba (2021:405) observed that social constructivism encourages students to apply practical methods to gain knowledge, reflect, and discuss their work in the classroom. These philosophies discourage memorising others' conceptions and definitions and encourage learners to discover their own work. Children can develop their straightforward explanation instead of memorising the age-extended definition of a phrase after investigating its placement in a sentence (Deeba, 2021:405).

Kanno (2018:89) affirms that active participation in the construction of knowledge by a group of learners who work collaboratively is central to social constructivism; hence, group or teamwork is needed to complete learning activities. This becomes evident in a Geography lesson where learners, as groups, are given projects on the computer to work on to identify different processes such as data layering, buffering, and data analysis. Okoro et al. (2020:4) share that social constructivism emphasises peer-to-peer collaboration, a learning group collaboration experience where social interactions and language are mechanisms for individuals to construct thoughts and concepts.

Ahmadvand (2022:2) argues that in social constructivism, students can learn to solve their problems on their own through interaction with their peers. It is through the social construction of knowledge that students work in groups. In a constructive classroom, the

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instructor interacts and negotiates with the students. The learners should construct knowledge by experience, so the teacher should engage learners actively in doing authentic as well as academic tasks, and help them to learn through what they do; students can never learn through their mistakes. Errors can work as feedback on students' learning (Amadvand, 2022:3). The study further adopted the Teaching Practice Allocation Resource Committee Model (TPRAC). According to Lee et al. (2021:3), this model is responsible for managing and supporting teaching practice for student teachers in managing curriculum changes. The authors further assert that it is a program offered by the Universities to support student teachers during teaching practice so as to adapt to curriculum changes. This model is relevant to the teaching of Geography because GIS has been introduced as a section in Geography.

According to Santos and Castro (2021:2), the Teaching Practice Allocation Resource Committee functions for resource assessment that is determining the number of teschers needed for each subject and grade; professional development which incudes allocating funds and time for teaher training and also to ensure that the schools have resources they need to provide quality education and support students success and this is relevant to the teaching and learning of GIS.9 (Santos & Castro, 2021:3). GIS requires maps and Learner Teacher Support Materials that are mostly technological; therefore, this model is suitable for this study.

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CHAPTER 3

LITERATURE REVIEW

This section provides a literature review of this study.

3.1 INTRODUCTION

This section provides acceptable standards for teaching Geography, GIS, and research-based strategies that could be explored to minimise the challenges experienced by learners and teachers concerning GIS. Researchers have come up with a number of strategies and practices that are helpful to the quality of GIS teaching in the Further Education and Training Phase (FET). Such strategies include but arenot limited to the following: The use of Information and Communication Technology ICT, The use of item and error analysis, the use of Mother Tongue, Learner Profiling, retraining of subject teachers, involvement of Geography curriculum advisors, engaging Geography makers, and moderators, delivery of supplementary tuition and outsourcing of Geography specialists, benchmarking, GIS Days, fieldwork, discussion sessionsand so forth (Leepo, 2015:67).

3.2 THE USE OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)

According to Mcube (2018:40), ICT is crucial in Geography because it encourages collaboration, critical thinking, and a learner-centred classroom. The integration of ICT in Geography calls for several changes in teaching and learning because it necessitates the shift from a behaviourist to a constructivist approach to teaching. The utilisation of contemporary technologies in teaching contributes to the faster achievement of the educational goal, which is why GIS may be considered a technique with the potential for Problem-Based Learning (PBL) and Enquiry-Based Learning (IBL) (Danjuana, 2014:1). In countries such as Serbia, as pointed out by Njoku (2016:2), the utilisation of Information

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and Communication Technology in the teaching GIS facilitates the development of functional, geographic knowledge and skills.

Research conducted by Njoku (2016) has shown that students who can use modern teaching aids in the learning process develop geographical knowledge, skills, and attitudes more effectively. GIS, by nature, enhances enquiry-based skills compared to traditional geographical education (Njoku, 2016:2).

According to Leepo (2015:96), integrating Information and Communication Technology (ICT) into the curriculum is one of the immense benefits to the learners. Firstly, learners who are exposed to ICT develop some skills that help them analyze information. Secondly, the introduction of ICT into the curriculum allows learners to become prime creators of their knowledge. For example, in GIS teaching, learners are given maps to manipulate and interpret data, and this helps them produce their knowledge without the help of the teacher.

Information and Communication Technology helps learners conduct Internet research (Mcube, 2018:40). The author further states that learners can present the lesson using technology. For example, the use of maps and satellite images when working on vector, raster data, data interpretation, and images of GIS satellites could be taught through ICT. Some GIS lessons are broadcast on radio, television, and satellites, and this becomes possible through ICT applications. Subject teachers, curriculum advisors, and other subject specialists mostly use computers and other software to prepare and present lessons, and these make it easy for the learners to download the information and insert it into their own gadgets to listen to it while working independently. In Limpopo Province, the South African Broadcast Corporation (SABC), in partnership with the Provincial Education Department, uses radio and television to broadcast lessons on different subjects, and this provides learners with opportunities to think and listen attentively, which, in turn, improves their skills such as listening, analytical and critical thinking (Mukondeleli, 2018:64).

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In some schools in South Africa, teachers are given laptops to prepare lessons and can download the information for their learners, and some information can be replayed to learners at the opportune time. According to Livingstone (2012:5), the use of Information and Communication Technology positively impacts learners' achievement, especially with skill development, understanding, interpretation, application, and presentation, especially on subjects such as Geography, in general, and GIS, in particular. Through ICT, the learner's retention and memorisation skills are improved, and teachers can also use ICT to encourage group work and interactive lessons, which could improve attendance and concentration (Leepo, 2015:96).

3.3 CAUSES OF LOW STUDENTS' PERFORMANCE IN THE GEOGRAPHICAL INFORMATION SYSTEM

The Geography curriculum has changed, and it now focuses on interpretation, analysis, and data manipulation. This puts learners who are doing Geography GIS at risk of performing dismally low and, thus, disturbing. Researchers such as Eze (2018:25) observed that interpretation and analytical types of teaching and learning are difficult for learners and teachers to understand GIS in Geography.

Adeyemi and Cishe (2016), Mohammed (2014), and Rilwani et al. (2014) observed that incomplete syllabi, poor teacher qualifications in Geography, a lack of laboratories, and the teachers' negative attitudes and background in subjects such as physical sciences and mathematics exacerbate these challenges in Geography. The same researchers further observed that teachers' lack of analytical and interpretation skills, poor lesson plans, and insufficient preparations make Geography teachers teach this subject with difficulties, contributing to learners' low performance in Geography.

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3.4 STRATEGIES THAT CAN BE ADOPTED TO ENHANCE PERFORMANCE IN THE GEOGRAPHICAL INFORMATION SYSTEM

3.4.1 Learner Profiling

According to the Department of Basic Education (2019:50), learner profiling is one of teachers' best strategies to improve learners' performance in different subjects. Learner profiling means identifying learners with varying learning styles and teaching them using various approaches; hence, learners have different paces and styles of learning. Learner profiling helps the teacher identify these learners' problems, strengths, and talents. In doing so, the teacher will use different teaching methods that accommodate these learning styles to improve learning performance. In teaching Geographical Information System (GIS), learners can be profiled and grouped according to their learning styles and be given the necessary support based on their performance (DBE, 2019:50). Geographical Information System (GIS), which is challenging to teach, requires teachers to use group work, cooperative learning, problem-solving, interpretation skills; hence, it deals with data manipulation. Through learner profiling, slow learners and learners with some disabilities can adapt through group work, where learners with similar content challenges are profiled, and individual or group attention comes to the fore (Mukondeleli, 2018:51).

3.4.2 Simplifying the GIS Language

The terminology that underpins the Geographical Information System is often difficult for teachers to interpret and understand. These teachers can simplify the language involved in the topic of GIS to provide the learners with opportunities and accessibility to learn and understand GIS effectively (Mukondeleli, 2018:27). The author reveals that teachers should encourage learners to have a Geography dictionary because it explains the terminology that is easy to understand. Consequently, geography teachers should be fluent in English used to teach GIS, and teachers can simplify the language used in teaching GIS by familiarising these learners with the words often used in GIS, for

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example, data manipulation, spatial resolution, remote sensing, and so forth. The teacher's use of simple language when teaching GIS will enhance the learner's understanding, thereby understanding the GIS language altogether (Mkhongi & Musakwa, 2020:4).

3.4.3 School Clinics

School clinics mean teachers help each other share intervention strategies that could be adopted to improve the learner's pass rate in schools; for example, teachers teaching social sciences subjects can work together to share strategies to improve learners' performances. On the other hand, schools that are performing in Geography can share strategies with underperforming schools to improve learners'performances in Geography (DBE, 2019:26). The teachers from the underperforming schools can attend lessons and observe the teaching strategies that the teachers in the host school adopt to improve learners' in the subject, and it can be done by teachers visiting schools with good performance instead outsourcing the same teachers to their schools.

According to DBE (2019), in every school, there should be clinics for every subject, clinics for circuits, and even clinics for districts and provinces, respectively. In other words, school clinics serve to give academic medication to underperforming subjects, schools, circuits, districts, and provinces in terms of curriculum management; by so doing, school improvement plans come to the fore.

3.4.4 Teaching GIS Vocabulary Rigorously

Geographical Information System vocabulary, such as vector, data, and raster data, buffering, remote sensing, resolution, attribute data, spatial data, and so forth, should be taught to learners rigorously (Mukondeleli, 2018:67).

The vocabulary mentioned above can be studied rigorously when used in each Geographical Information lesson. Learners can do a repetition of GIS words in their learning environment. Teaching vocabulary in GIS and doing presentations daily can

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improve the learners' performance in GIS. Learners advance their understanding of GIS by being exposed to a list of words in simulations and games, and drilling and repeating it in their daily lessons. The identical learners who gained sufficient GIS vocabulary will be able to discuss with pride and confidence in GIS lessons (Mukondeleli, 2018:68).

3.4.5 Modelling GIS Teaching to Learners

Makhuvha (2015: 35) posits that teachers can use modelling to teach learners about GIS in the classroom. This modelling can take the form of teaching using geographical language, communicating slowly, and using simple language and tone that are easy to understand in the classroom. The teachers should avoid using bombastic words, avoid words with double-barreled questions and expressions, and instead use clear language that is easy to understand. Furthermore, teachers should engage their learners in GIS using debate, symposium, and classroom dialogue. On the other hand, teachers should give learners ample time to deal with the Geographical Information System challenges and questions. Through modelling, GIS can be simplified, such as the Geography map work tasks (Makhuvha, 2015:56).

3.4.6 Encouraging the Use of Mother Tongue when Teaching GIS to Learners

According to Strass (2016:15), teaching and learning in their home language stimulate understanding of information in the second language as modification occurs. Learners' home language is of paramount importance in the teaching and learning of Geographical Information Systems. Makgatho (2018:4) affirms that the ability of the learners and teachers to communicate with each other in their own language constitutes good performance in essay subjects. Teachers need to be multilingual speakers; if needed, they should allow learners to answer in their own language. Makhuvha (2015:45) asserts that code-switching facilitates language development as a mechanism for providing language samples in the classroom discourse, and it promotes interaction among the learners because it is through language that the literate life history of learners in the classroom can be understood. Therefore, using English as the medium of instruction can be complemented by the home language when teaching GIS (Mukondeleli, 2018:23).

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3.4.7 The Use of Illustrations when Teaching Learners GIS

Demicry (2022:60) states that when teaching GIS to learners, the teachers can use illustrations, sketches, and drawings to support communication in the classroom. Learners will easily understand and remember the learning content through illustrations, sketches, and drawings. Teachers can also use models and presentations to enhance learning, making it easy for learners to understand the Geographical Information System (Demicry, 2022:6).

3.4.8 Teach GIS in Terms of Policy Documents

According to the Department of Basic Education (2011:6:3), Geography teachers in the Further Education and Training Phase, that is, Grades 10 to 12, should use the policy documents to teach GIS. This policy document includes a summary of topics per term, the Annual Teaching Plans (ATPS), and the Programme of Assessment. The Section of Geography called GIS is included in this policy document. Teachers are also allowed to use Annual Teaching Plans (ATPS) and other relevant documents to supplement the quality of teaching.

The central agreement in GIS teaching is that skills, knowledge, attitudes, and values should be integrated into the Geography curriculum. The aim of teaching GIS is to teach learners to practice skills such as data capturing, data manipulation, data analysis, and critical thinking. Regarding acceptable standards of GIS, GIS-specific skills, such as buffering, data interpretation, and data evaluation, should be emphasised. In terms of attitudes and values, teachers should teach learners values such as fairness, multilingualism, responsibility, respect, compassion, and appreciation (DBE, 2012:9).

According to Felix (2021:83), lesson planning and preparation are key for GIS teachers. When a teacher attends classes, it is vital that lesson plans, learning programmes, and work schedules are available. Additionally, the teachers must have a work schedule and a programme of assessment within each grade so as to teach efficiently and effectively. Tshililo (2016:45) concurs that it is the responsibility of the teachers to bring lesson plans

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into the classroom so that effective teaching takes place, and this is vital for the learners to understand the learning content.

In terms of learner assessment, it is the teachers' responsibility to give learners tasks, mark the given tasks, give the learners feedback, and record the tasks as part of quality teaching and learning (DBE, 2012:40). The Department of Basic Education further states that the purpose of the assessment is to continuously gauge the learner's progress, diagnose the learner's problems, and promote the learners to the next grade, and so forth.

3.5 INFORMATION AND COMMUNICATION TECHNOLOGY MATERIALS THAT ENHANCE PERFORMANCE IN GEOGRAPHIC INFORMATION SYSTEMS

Mkhongi (2019:25) asserts that creating GIS resources, such as computers and other software, supports teachers and curriculum advisors of Geography, researchers, and communities; since they are the ones involved in GIS instruction in schools, they could be a solution to improving results in Geography. Teachers teaching GIS as a section of Geography need to be competent and qualified in using technologies, and capacitating those responsible for Geography is a prerequisite because their knowledge can contribute to a positive learning environment. For educators to have confidence in teaching GIS, they would be empowered, guided, and supported through technology-integrated pedagogies and the provision of specific technology-based lesson plans. In countries such as Nigeria, Turkey, and Kenya, traditional textbooks have been replaced with computer programmes on tablets so that technology-integrated pedagogy can be achieved, and as such, teachers without technological knowledge are decreasing (Blu Dot, 2018:15).

3.6 THE CHALLENGES EXPERIENCED BY TEACHERS WHEN TEACHING

3.6.1 Geographical Information System

Researchers such as Seremet (2016:65) pointed out that GIS, as a section of Geography, needs critical, analytical, and interpretive skills, and all these skills

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necessitate learners to think abstractly. Chew (2018:50) echoed the same sentiment when he noted that most learners do not perform well in Geography GIS because they have insufficient skills for data interpretation, data analysis, data manipulation, and so forth. Geography GIS relates to subjects such as Physical Science, Geoinformatics, Mathematics, Mathematical Literacy, and Environmental Sciences, and these serve as the challenges for Geography learners in general, and GIS, in particular.

The National Examination Diagnostic Report for Geography (2020:71) describes that most learners performed poorly on GIS, as it deals with data interpretation, and most learners do not bother to answer such questions. It is further stated in the same report that common errors and misinterpretations were in data interpretation, data analysis, data manipulation, and data identification. Consequently, the researchers who currently research GIS observed that learners were also challenged by Question 3.3 of the GIS question paper of 2020, which assesses data identification, classification, and data interpretation. As such, learners' performance in these questions is low and disturbing. Most learners cannot apply and link the knowledge gained in the theory part of Geography to the GIS question paper. The mapwork section also challenges the same learners, as they also perform poorly in that section (Diagnostic Report, 2020:18).

Having assessed GIS as an integral part of Geography teaching, the DBE (2012:62) admits that assessment is vital for the learners' future in class. Geography in the Further Education and Training Phase (FET) is assessed as follows:

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Table 3.1: Grade 12 2023 Programme of Assessment (P0A)

Grade 12 2023 Programme of Assessment (P0A)					
Term	**Assessment**	**Type of Assessment**	**Raw Mark**	**Term Weighting**	**SBA Weighting**
1	1	Map work	60	25%	15
		Mid-Term Test (Climate & Weather)	60		
	2	Controlled Test	60	75%	15
2	3	Research	100	25%	15
		Mid Term Test (Geomorphology)	60		
	4	Mid-year Exam	150		
		(P1 Physical) (P2 Settlement)	150	75%	20
3		Mid Term Test	60		
	5	Controlled Test	60	25%	15
	6	Preparatory (paper 1 and 2)	300	75%	20
	SBA				25%
4		End of year examinations (paper 1 and 2)	300		75%

Source: DBE, Programme of Assessment for Geography 2023

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3.7 TEACHING AND LEARNING EXPERIENCES OF GEOGRAPHICAL INFORMATION SYSTEMS IN TURKEY AS A DEVELOPED COUNTRY IN EUROPE, NIGERIA, AND SOUTH AFRICA AS A DEVELOPING COUNTRY IN AFRICA

In this section, attention is given to how learners respectfully experience the teaching and learning of the Geographical Information System in both developed and developing countries in Europe and Africa.

3.7.1 GIS Teaching in Turkey

Like in developing countries, learners in Turkey experience challenges in the mainstream classroom. Those challenges are attributed to, among others, technological and curriculum-related as well as physical challenges or infrastructural challenges. The following section examines and discusses the impact of those challenges.

3.7.2 The Technological Challenges

Seremet (2016:90) states that the introduction of GIS in the Turkish curriculum in 2005 has brought about some degree of fear and anxiety among teachers teaching Geography. Clark and Kiraz (2016:18) affirm that technological materials and other software make teachers adapt to new technological materials. Seremet (2016:92) highlights that Geographical Information Systems make it difficult for teachers to teach effectively due to a lack of digital data, difficulties in using GIS software, and unwillingness on the part of teachers as instructors to utilise Geographical Information System Technology. According to Mkhize (2023:64), the professional staff development and the high teacher-student ratio exacerbate and impede the successful implementation of the GIS curriculum. The author adds that the Turkish curriculum has been shortened for many years and is frequently changing, and as such, teachers teaching GIS are frustrated and find it difficult to adapt. To exacerbate the situation, there is low quality of teaching, weak assessment, a lack of equipment and rigging, and the reaction of teachers teaching GIS (Mkhize, 2023:32).

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According to Seremet (2016:67) and Bayir (2021:35), the training of GIS educators in Turkey is ambiguous; experts do not prepare the GIS course books, and the GIS books are of low standard and are just published for commercial purposes. All of the above impede the introduction of GIS education in most Turkish schools. Bair (2021:43) further argues that books published for GIS are prepared mainly by teachers with no academic aims or who have no first-hand experience in secondary school education; the books have scientific errors and are only published for commercial purposes. Mkhize (2023:60) concurs that the teachers' lack of knowledge and understanding, and teachers teaching GIS topics from a theoretical perspective without integrating practice, also impede and challenge the introduction of GIS education in some Turkish schools.

3.7.3 Physical and Infrastructural Challenges

The physical infrastructure includes, but is not limited to, classrooms, buildings, electricity, and power supply that the school system needs to function correctly. In countries such as Turkey, like in South Africa, the Geographical Information System also faces enormous challenges, such as insufficient infrastructure. Seremet (2016:94) asserts that GIS Education in Turkey is characterised by traditional teaching and assessment methods instead of using a variety of innovative activities and experimental learning that students enjoy and which underpins deep learning. While acknowledging that conventional approaches have their place, there are advantages in contemplating these with more extensive activities such as teamwork, student research projects, games, debate competitions, real-world simulation, and more use of new technologies (Seremet, 2016:153).

The Geographical Information System classroom requires learners to work in groups and individually in operating computers and other software. In Turkey, overcrowded classrooms are some of the challenges that teachers are faced with, and as such, these classroom shortages impede good teaching practices, which results in learners' poor performance in Geography GIS (Artinli, 2016:43). Demicry (2018:188) advises that managing overcrowded classroom isa challenge to teachers teaching GIS, and this is one

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of the contributing factors that cause poor performance among learners doing Geography GIS.

3.7.4 Curriculum Challenges

In countries such as South Africa, Malaysia, and Turkey, curriculum changes have changed subjects and content. In Turkey, curriculum changes took place in 2005, and the Geographical Information System was introduced. Multiple authors, such as Incekara (2010:556), opined that the Geographical Information System resulted from the curriculum changes as it brought computers to the desktop, especially in the Geography secondary school curriculum.

Degirmenci (2018:3) concurred that the Turkish Education System changed the curriculum in 2005 by introducing technology within the Geography curriculum. The strong emphasis was on using ICT and introducing a Geography reform system as part of Geography. Seremet (2016:34) postulates that the introduction of GIS education in Turkey has also brought about the challenges that go with it. These include the use of ICT and other software, hardware, and digital data, the deficiency of teachers in the use of computers, and the lack of training of teachers about the aims of curriculum matters.

According to Degirmenci (2018:51), teachers face challenges in the GIS classroom, including the unwillingness of teachers and the inadequate place of GIS in the classroom; hence, the classrooms are overcrowded. Degirmenci (2018:51) argues that GIS software has a huge technical demand where computers and other software are utilised, and it becomes difficult for teachers to teach GIS effectively due to the high demand for the Web of Information and Communication Technology. Based on the lack of ICT and other software on the part of teachers teaching GIS, the learners' performance in Further Education and Training, where GIS is assessed, tends to be low and disturbing. Kholoshyn (2021:4) asserts that in countries such as Turkey, most teachers have insufficient knowledge about GIS and are not trained adequately on how to teach GIS effectively, which later affects the academic achievement of learners in Turkey.

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Incekara (2012:83) and Degirmenci (2018:4) state that GIS is working closely with multiple skills, such as data capturing, data manipulation, and data interpretation, and other related materials. These curriculum changes require teachers to be competent in the use of ICT. In essence, teachers are required to change the way they teach, which is by switching from traditional teacher-centred teaching methods to learner-centred methods, which encourage active participation by the learners.

3.7.5 The Attitudes of Turkish Teachers towards GIS

According to Artvinli (2008:447), the Turkish Education System's teaching approach has been changed from teacher-centred to student-centred learning by increasing the awareness of constructivism in the Geography curriculum. Incekara (2013:24) asserts that using Information and Communication Technology is one of the best learning activities for Geography classes because it helps teachers make their lessons student-centred and use active methods. Regarding general Geography teaching and GIS, attitudes play a key role in success and learners' passing rate (Incekara, 2013:76). This is the view of Atrvinli (2008:447), who echoed that teachers' attitudes and professional responsibilities affect the lack of GIS applications in schools.

In the Geography GIS computer room, organising excursions to GIS places is of paramount importance in instilling curiosity, eagerness, and positive attitudes towards GIS (Seremet, 2016:6). The majority of teachers do not understand the social construction of knowledge and information, critical, analytical, and data interpretation skills. As such, these became vague towards Geography teaching and GIS, in particular. If teachers lack those required skills to teach, they develop negative attitudes towards GIS, and this will discourage the teachers and lead to low learner academic performance in GIS. Artvinli (2008:72)observed that teachers' negative attitudes and perceptions towards curriculum changes were some of the challenges found.

Degirmenci (2018:19) argues that teachers are resistant to learning the use of Information Communication Technology (ICT), as well as the inability to devote time and effort to learning and teaching GIS using new technologies. Sermet (2016:51) concurred that the

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majority of teachers had not received their education on GIS, and this results in negative attitudes towards Geography GIS, leading to learners' poor performance in GIS.

Alladag (2014:1534) affirms that Geography GIS requires teachers to have positive attitudes towards Information and Communication Technology. Therefore, one of the challenges to the improvement of learners' performance in GIS is the teacher problem. Seremet (2016:42) speculates that teachers and the curriculum are the problems in the implementation of GIS because the majority of them use the traditional teacher-centred method of instruction, while GIS requires the use of the student-centred approach to instruction, which requires learners to be active in the teaching-learning environment.

3.7.6 Teaching and Learning Resources

According to Degirmenci (2018:191), the GIS curriculum in Turkey seems to be a challenge to implement. According to the study conducted by Degirmenci (2018) on the availability of ICT in schools, it was found that the lack of sufficient hardware and software, the lack of classroom environments suitable for the use of GIS, and teachers not being competent at using GIS are some of the challenges in Turkey. Seremet (2016:53) posits that teachers' deficiency in computer skills and other software makes GIS difficult to teach because GIS requires teachers who are computer literate. The study conducted by Artvinli (2018) revealed that some teachers are reluctant to adopt the GIS style of teaching because they do not have information about GIS. Other Geography teachers lack the conviction to use GIS applications. On the other hand, lack of information and skills in using personal computers, a lack of training on the part of teachers on how to teach and use GIS applications, and a lack of electricity in some schools, especially the rural, remote schools, make it difficult for some teachers to teach GIS effectively (Artvinli, 2018:63).

Generally, GIS requires resources that are computer-compliant, which include but are not limited to digital data, software, computers, classrooms, and GIS laboratories; therefore, the shortage of some of the above resources and other related materials serves as a barrier to the introduction of GIS into the Geography curriculum.

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The scenario above is supported by Seremet (2016), Artvinli (2018), and Incekara (2010) when they argue that lack of training on the use of GIS in the classroom, a lack of sufficient hardware and software in their school, inappropriate classroom laboratories environment, a lack of GIS laboratories and other resources that needs data and computers to operate are some of the obstacles or challenges affecting the introduction of GIS to Geography as a subject. Kholoshyn (2021:5) concurs that some problems facing teachers teaching GIS are the lack of skills and materials that can be used, as well as the lack of support from the principals and the Education Department to provide data, software, and training to teachers about GIS infrastructure, in general.

Maric (2022:28) affirms that the lack of space in the classroom and informatics is not suitable for the Geography GIS education and the Geography GIS classroom. Additionally, inadequate resources and other equipment for Information and Communication Technology, ignorance of the working software, and lack of smart boards and computers make it difficult for teachers to implement GIS effectively (Maric, 2022:28).

3.7.7 Teaching Approaches for Geography GIS in Turkey

Artvinli (2018:49) states that most of the Geography teaching methods in Turkey have been shaped by teacher-centred training methodologies. The above-mentioned methods mean these teachers are using traditional teaching, where learners are regarded as passive recipients of information and knowledge from the teachers. These teaching methods encourage rote learning and memorisation of information by the learners. This is one of the challenges faced by teachers teaching GIS lessons. GIS classrooms require learners to participate actively in the learning process, which means that this method is suitable for GIS lessons (Kanno, 2018:45).

The traditional teaching methods relegate the learners because teachers dominate the lesson while their learners serve as the passive participants during learning, thus decreasing the learners' participation and thereby affecting learners negatively when they study GIS. The use of the teacher-centred method of teaching means the teachers use rote learning methods, drilling methods, and question-and-answer methods, and this

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leads to learners being the spectators in the classroom instead of being active participants, while learners are listening to the teacher passively. In traditional teaching methods, teachers act as the masters of the learning content, while learners are passive recipients of knowledge (Omwhirehen, 2018:34).

3.7.8 Geography GIS Teaching in Nigeria

In this section, the researcher discusses the challenges that learners experience when they learn GIS in Nigerian schools, the attitudes of learners towards GIS, gender differences in terms of GIS performance, and the number of teachers who are competent in GIS.

3.7.9 The Attitudes of Nigerian Learners towards GIS

The learners' attitudes towards Geography GIS cannot be underestimated. Mohamed et al. (2020:40) argue that those learners' negative attitudes towards Geography GIS were caused by different variables: Geography teachers not teaching well, different textbooks, and expensive GIS materials. Sumari (2018:67) concurs that Geography is not considered a fundamental subject like Mathematics, the English language, and the Nigerian language. To that effect, most students neglect the discipline of Geography, and others just study it to earn the required number of credits to gain admission to a tertiary institution.

Degirmenci (2021:1) and Seremet (2018) posit that inadequate and poor preparation by the teachers harms the learners doing GIS, and this creates the impression that this subject is difficult to understand. Therefore, such learners develop negative attitudes towards the subject as well as poor attitudes towards Geography. Consequently, poor attitudes towards the subject, as well as inadequate and poor presentation of geographical features and concepts by the subjectteachers, make it difficult for the learners to understand, and this places the learners ata crossroads opting to view the subject in a negative eye which place the same learners at risk of failing the subject, hence negative attitudes towards Geography GIS (Gbendu & Ezeudu, 2018:54).

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Geography GIS deals with data handling, data interpretation, data manipulation, lines, polygons, and points that incorporate Mathematics and Mathematical Literacy as well as Physical Sciences concepts. The most challenging GIS concepts and aspects are mathematical as well as integrated Mathematical Literacy and Physical Sciences; thus, the learners' performance in Geography GIS will be low.

Onuoha (2014:73) opined that learners' performance in Geography GIS emanates from a lack of understanding, difficult textbooks, improper teaching, and the perceptions the learners have about some topics in GIS that are mathematically inclined. The study conducted by different researchers, such as Rilwane, Alcahomen and Mohamed (2014:35), revealed that the majority of learners performed dismally low in GIS, followed by the map work section, and physical Geography, while in human Geography, the learners performed better. The same researchers affirm that the learners' low performance in Geography GIS is attributed to negative attitudes and perceptions the learners hold about GIS. Mohamed (2020:81) opined that most of the challenges experienced in most Nigerian schools that cause poor performance of Geography GIS are attributed to a lack of information and reluctance to operate Information and Communication Technology in class.

Eze (2021:7) remarks that poor teaching in schools in Nigeria results in learners' lack of knowledge, curiosity, and interest in Geography GIS. Eze (2018:8) adds that inadequate preparation and presentation by the teachers and inadequate explanation of points by the teachers make it difficult for the learners to understand GIS, and this creates a wrong impression about GIS among the learners in many schools in Nigeria. Some of the schools(especially public schools) did not complete their syllabus as evidenced by the performance of their candidates, and the poor teaching skills where teachers do not teach their subjects the way they should (Eze, 2018:10).

However, authors such as Mohamed et al. (2020:9) suggested that since the majority of learners in Nigerian schools lack interest and curiosity and have negative attitudes towards GIS, the following measures can be adopted: arouse the interest of the learners, motivate learners and change learners' attitudes, provision of infrastructural materials

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such as Information Communication Technology, and provide physical and virtual laboratories. Teachers should also change their teaching methods from a teacher-centred to a learner-centred approach, which encourages learners to be active participants in the learning environment, as this will enable the use of innovative learning strategies in teaching and learning in the laboratory environment and further improve the attitudes of students towards Geography, irrespective of their gender (Filgona & Sababa, 2016:11).

3.7.10 Learners' Analytical and Interpretive Competence in GIS

The Geography map work has its foundation in subjects such as Mathematical Literacy, Mathematics, and Physical Sciences, and these three subjects are both interpretive and analytic. The influence of Mathematical Literacy, Mathematics, and Physical Sciences in Geography as a discipline has made the subject challenging for the learners when they learn, among others, to analyse, interpret, and handle data. Data analysis and handling, interpretation of graphs, maps and data polygon graphs, buffering places, pixellating raster images, remote sensing, and satellite images have bearing ground for Mathematical Literacy, Mathematics, and Physical Sciences (Ezeudu & Gbendu, 2018:43). Eze (2018:19) observed that most learners have challenges in analytical and interpretative competence as Geography GIS deals mostly with analytic and interpretation skills, and learners always find it difficult to understand.

In Geography as a subject on its own, learners perform better but find it difficult to do well in aspects of Geography, such as map work and GIS, simply because of the mathematical background (Eze, 2018:20). In addition to Geography, GIS learners who study, History, Economics and Business Studies are sometimes not good at Mathematics, Physical Sciences, and, Mathematical Literacy, and they encounter analytical and interpretive phobia. Interpretive and analytical phobias are some of the factors that serve as a challenge when learners learn Geography and Geographical Information Systems in countries such as Nigeria. Eze (2018:21) remarks that there is a relationship between learners' mathematical and geographical abilities because low and high averages are found in both Mathematics and Geography.

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Onuaha (2014:75) claims that GIS, a section in Geography, seems to be difficult for the learners to understand because of a poor background in Mathematical Literacy, Mathematics, and Physical Sciences. Eze (2018:49) declares that Geography GIS involves different types of knowledge on topics such as data handling, interpretation, and analysis. Learners are required to have procedural knowledge and concepts, laws and rules. For example, the learners are required to interpret data; the same learners have to follow some procedures for carrying out the task under challenging steps. The learners need to identify the requirements for carrying out the task and demonstrate declarative memory. For example, learners must have analytical skills when working with data analysis in GIS (Onuaha, 2014:76).

The learners' deficiency in interpretive and analytical competence in Geography GIS during data interpretation and analysis seems challenging in Nigeria. According to Adeami and Cishe (2016:157), learners need to have different types of knowledge in order to work with GIS. The different types of knowledge complement each other because learners require different skills in order to understand map work. Adeyemi and Cishe (2016:158) further argue that mathematical competence is necessary in GIS because learners must analyse and interpret data. Learners are required to handle data on diagrams and images, interpret data from graphs, and analyse data based on different information provided in the form of diagrams, interpret graphs, and so forth.

Geography GIS has its roots in subjects such as Mathematical literacy, Mathematics and Physical Sciences. Adeyemi and Cishe (2014:160) further proclaim that learners who have mathematical inability find it challenging and complex to answer questions related to GIS, and this has a negative impact on these learners' achievement in Geography GIS. The learners mostly find it difficult to answer questions that require the ability to interpret graphs, data, and any other related information. The matter is also worsened by the teachers who are afraid to teach Geography GIS. In Nigeria, the majority of teachers do not use the appropriate strategies for teaching Geography. These subjects require the learner's competence in, among others, data manipulation, interpretation, data handling, and analysis, and this teacher's inability to use appropriate teaching strategies has a

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negative impact on the learner's achievement in Geography (Adeyemi & Cishe, 2014:159).

Eze (2018:17) echoes the same sentiment when he observed that Geography GIS seems difficult for the learners to understand due to its interpretative, analytical, and manipulative data in nature; hence, these skills are mathematical and require particular skills. Therefore, the learners need to have mathematical knowledge, skills, and attitudes in order to understand Geography GIS properly.

A study by Filgona and Sababa (2017:1) shows that gender performance in Mathematics is oriented towards subjects that favour boys over girls. This scenario points out that there is a relationship between poor performance in Mathematics, Geography, and gender. Filgona and Sababa (2017:3) exposed that there is a low enrolment and poor academic achievement of female students in Geography compared to their male counterparts. The research correlation affirms that girls' performance should be adapted, and teachers should be trained to be familiar with the use of current approaches, especially the use of modern laboratories. These findings suggest that the teachers' learning and teaching methods in Geography GIS are difficult to understand. The same teachers lack competency and have a phobia of GIS when teaching, and these are some of the challenges learners experience when studying GIS.

3.7.11 Gender Differences in Geography GIS

The influence of gender differences concerning Geography GIS is one of the challenges learners experience in studying the subject. Filgona and Sababa (2017:2) suggest gender differences in subjects such as Mathematics, Physical Sciences, and Geography. GIS girls' performance is lower than that of boys. There is a clear indication that gender dichotomy plays a critical role in the choice of subjects as well as the performance of learners in particular subjects, for example, Mathematics, Geography, and Physical Sciences.

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Filgona and Sababa (2017:51) add that in certain cultures, science subjects are masculine, meaning that examination achievements are socio-cultural based on the differences between boys and girls. Some vacations and professions have been regarded as men's (engineering, arts and crafts, and agriculture, etc.), in contrast to others as women's fields (catering, typing, and nursing, etc.) (Filgona & Sababa, 2017:14). The study conducted by Mohammed (2014:109) titled discovered that teaching Geography map work is dominated by males. Consequently, the same study points out that Geography map work, like GIS, is dominated by male teachers, who constitute 85%, while their counterparts, that is, female teachers, constitute 15% of teachers teaching map work and GIS, respectively.

Rilwani et al. (2014:36) affirm that most of the teachers teaching Geography map work and GIS are male, 82.14%, while the remaining percentage of teachers teaching Geography map work are female. The above scenario reflects that gender differences also extend to the area of subject specialisations.

Some authors, such as Adeyemi and Cishe (2016:170), concurred that fewer female learners register for Geography at the tertiary level than in Mathematics, Physical Sciences, and even engineering. This implies gender differences in curriculum specialisation, including Geography map work, and GIS play a unique role in the subject choices.

3.7.12 Changes in Curriculum

A frequently changing curriculum in Nigeria's education system, like in South Africa and other developing countries, has far-reaching consequences. Those changes date back to the 1960s and have brought about some degree of fear among teachers teaching Geographical information systems. The introduction of Geography GIS, like the map work, was met with mixed reactions (Mkhongi & Musakwa, 2020:4). The GIS section of Geography seems difficult to teach; as a result, the learners' performance in Geography that assesses GIS indicates that the results are neither low and disturbing (Filgona et al., 2016:2). In countries such as Nigeria, the subject Geography is optional; thus, learners

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who are doing Mathematics and Physical Sciences are not doing Geography. This means that learners who are not that gifted are the ones doing Geography (Mohammed, 2014:107).

1.7.13 School Timetable and Administration

Filgona et al. (2016:2) advise that school administration and timetabling are some of the challenges learners experience when they study Geography map work and GIS; hence, these sections are taught concurrently. It is against this background that the school timetable is one of the variables that causes learners' low performance in some subjects, and Geography, in particular.

Amosun (2016:45) reveals that GIS needs a lot of reading and interpretation, and analysis, therefore requiring a lot of time, and the school timetable should provide enough time to study Geography. Amosun (2016:46) adds that Geography needs three periods per teaching time, and two should be double periods, as map work and GIS require plenty of time for teaching and practical work. The author went on to say that some schools do not have three periods for Geography; hence, practical work is of paramount importance in map work and GIS. To that extent, the majority of learners are performing dismally low due to a lack of enough time for Geographymap work and GIS. The above scenario makes it difficult for the teachers to teach Geography effectively.

Amosun (2016:46) attests that Geography teachers are frustrated because double periods are meant for other subjects, while Geography and Geography teachers are ill-treated when requesting double periods for their subject. In this regard, learners believe that Geography map work, which also includes GIS work, is difficult to understand because it is allocated insufficient time and periods, and the school timetable does not offer the required period for the subject since it is practical (Amosun, 2016:47).

Filgona et al. (2016:6) affirm that learners perceive Geography maps as difficult to understand due to inadequate time and periods allocated to them, and this results in poor and low learner performance in the subject, in general, and GIS, in particular. To a certain

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extent, some teachers are unable to cover the content, which has a negative impact and results in the learners' performance in Geography being low and unevenly distributed.

3.8 TEACHING AND LEARNING METHODS OF GIS IN NIGERIA

In Nigeria, the majority of teachers are using traditional teaching methods, which are outdated and inappropriate for the teaching of subjects such as Geography. According to Adeyemi and Cishe (2014:50), poor methods of teaching are one of the contributing factors to learners' poor performance in Geography. The authors further asserted that the majority of learners perform poorly in Geography due to a lack of competency on the part of the Geography teachers, the poor methodology as well as the difficulties the teachers face when teaching learners as well as poor methodology. The teaching methods that are poor and inadequate resources serve as a barrier tolearnersin mapwork and GIS (Adeyemi & Cishe, 2014:52). The authors further state that the most traditional teaching methods frequently used in GIS teaching are memorisation, rote learning, drilling, question and answer, telling methods.

A number of authors, such as Filgona and Sababa (2016:2), affirm that teaching methods that are conventional, characterised by the lecturer method, have little impact on improving the learners' interest because the learners are passive recipients of knowledge and information. Eze (2018:66) attests that poor teaching methodology is the reason behind poor learners' performance in Geography. In terms of poor learners' performance, Adeboye (2015:24) point out that the teacher-centred method isconcerned with content coverage whichresultsin poor learners' performances in Geography,while the learner-centred approach is the best because it gives learners an opportunity to be active participants in the teaching and learning processs, resulting in better performance in Geography.

Adeyemi and Cishe (2014:23) assert that the majority of schools in Nigeria are using traditional methods of lecturing, which do not bear any fruit. Agreeing with the above assertions, Amosun (2016:45) and Filgona and Sababa (2016:2) assert that teaching

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Geography map work includes GIS, thus using the traditional methods of teaching discourages maximum participation by learners.

According to Adeyemi and Cishe (2016:155), the teaching styles that the teachers use in class also have a direct influence on the learners' academic achievement. Most of the teachers are struggling with the nature of the subject that they teach, coupled with inadequate time to allocate to their subject of three periods per week on the school timetable. For the teacher to complete the syllabus, the majority of teachers use the lecture method because it encourages memorisation of facts from the teacher as the departure point. To arrest the situation, the Nigerian Government should start workshops, in-service training, seminars, and conferences for the teachers to discuss, among others, the selection of suitable teaching strategies for Geography GIS teaching (Adeyemi & Cishe, 2016:156). The authors further opined that the table, teachers' competence in different sections of Geography and the suitable GIS teaching strategies, the duration of Geography lessons, and the use of Information and Communication Technology should be discussed in those sessions.

3.8.1 Teachers' Competence, Qualifications and Training

Incompetency, unqualified and underqualified teachers are some of the factors that teachers of Geography GIS are confronted with. Some researchers, such as Amosun (2016:18), believe that teachers' competency, training, and qualification play a critical role in the learners' performance, and this has a direct effect on the average performance of subjects, including Geography. In GIS, learners need to be engaged in data handling, data interpretation, and data analysis, and these factors need teachers who are qualified and competent.

Learners need to have interpretation, analytical, and data-handling skills in order to understand GIS easily. According to Adeyemi (2008:203), a learner's performance in Geography is influenced by the teacher's qualifications and experience in Geography, in general, and GIS and map work, in particular. This simply means that learners who are taught by unqualified, incompetent, and underqualified educators are likely to perform

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dismally low in Geography, GIS and other subjects. Adeyemi (2008:203) further points out that in schools in Ondo State, Nigeria, many schools that do Geography have underqualified and incompetent teachers, and these are some contributory factors towards the high failure rate in Geography GIS.

Filgona et al. (2016:3) assert that one of the reasons identified as the cause of poor performance in Geography, in general, and GIS, in particular, is the lack of qualified and experienced teachers who can teach learners effectively. Filgona et al. (2016:5) further posit that poor performance in Geography GIS, like map work, is attributed to either incompetent, underqualified, and unqualified Geography teachers. Basically, teachers who are not qualified in Geography are employed to teach. Consequently, this will contribute to low learners' performance in GIS in most Nigerian schools (Filgnona et al., 2016:7).

According to Amosun (2016:17), teachers who have no background in Mathematics and Physical Sciences are not prepared to teach Geography GIS because this subject requires teachers who are critical and analytical thinkers. Therefore, most of the underqualified and unqualified Geography teachers are reluctant to teach mathematically related questions in their examinations. The fact that teachers lack a mathematical background also affects learners because, like their teachers, the same learners avoid answering questions about Geography that are mathematically related (Filgona et al., 2016:9).

The majority of Geography teachers have content gaps, hence being either unqualified or underqualified. The same teachers do not have experience either in marking and being examiners of Geography, therefore learners' performance in Geography map work and GIS will be low (Amosun, 2016:3). Sumari (2018:73) further attests that playing hanky and panky with the Nigerian Union of Teachers over salaries, poor remuneration, and over-crowding, which resulted from poor infrastructure, exacerbate and impede the introduction of GIS in Nigerian schools. Mkhize (2023:58) concurs that inadequate teacher training, inappropriate teaching methods, and education authority-related methods are some challenges facing GIS implementation in Nigeria.

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3.8.2 Geography Teachers' Attitudes towards GIS

Multiple authors, such as Onuoha (2014:50), state that attitudes play a critical role in the teaching of Geography GIS; hence, Information and Communication Technology is used prominently. Negative attitudes have a potential effect on the behaviour of Geography teachers, in general, and Geography GIS teachers, in particular. For instance, attitudes influence the way the teachers teach and the way learners learn, and they also influence the teaching strategies used by the teachers. According to Filgona et al. (2016:3), the majority of teachers are reluctant to teach GIS, and they do not perform excellently because of the negative attitudes towards GIS, and the same teachers are not committed to teaching GIS because of a lack of technology-related materials and negative attitudes towards the subject.

Amuson (2016:46) affirms that teachers care more about themselves than about the academic excellence of their learners. They care less about the final results of their learners while caring more about their wages and salaries, if not paid at all. Negative attitudes of teachers towards Geography GIS contribute to low learner performance in the examinations. Onuoha (2014:51) reveals that GIS requires teachers who are computer literate and able to use Information and Communication Technology to teach learners. Either teachers have not attended workshops on GIS-related matters, or they do not attend in-service training and workshops, making them less effective in teaching GIS. The teachers' negative attitudes have a negative consequence on both the learners' attitudes and the learners' poor performance in GIS. Positive attitude of learners to perform better is influenced by the teacher's positive attitude towards their schoolwork (Anuoha, 2014:56).

Teachers' attitudes towards GIS should at all times be positive to motivate their learners to perform well in school. Mohamed et al. (2020:70) declare that the learners' academic performance in the learning and teaching environment is influenced by effective and efficient teachers in the classroom. Rilwaniet al. (2014:30) echoed the same sentiment that the teachers' positive attitudes towards the learning content motivate the learners to develop positive attitudes towards the same content that teachers are teaching.

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3.8.3 Learner Teachers Support Materials and other Resources

Chew (2018:50) argues that the success of Geographical Information Systems in schools depends largely on the availability of Information and Technology (ICT). Having more resources plays a critical role in the teaching-learning process. This means that to teach Geographical Information Systems effectively, it is important that schools have adequate resources, which include but are not limited to computers, software, books, and so forth. In countries such as Nigeria, inadequate learning and teaching materials used for teaching Geographical Information Systems (GIS) are a challenge, and this makes it difficult for teachers teaching Geography GIS to teach effectively. Lack of ICT when teaching GIS in schools is one of the variables that have been identified as the main cause of learners' low performance in Geography, especially in GIS (Filgona et al., 2016:3).

Additionally, learners' lack of instructional material, such as textbooks to use during teaching sessions, also exacerbates the situation. Chew (2018), Joseph (2023) and Leepo (2015) concurred that for teachers to teach Geographical Information Systems effectively, Information and Communication Technology (ICT) comes to the fore. Geography GIS requires a lot of learning and teaching materials, such as computers, software, laboratories, and so forth. In addition, Geography GIS requires teachers to have books, hardware, and enough classrooms to work effectively and efficiently.

BluDoT (2018:80) asserts that multimedia in countries such as Nigeria, Kenya, and Zambia has replaced the traditional textbooks and computer programmes on the desktop, which means that fewer skilled educators will be required. Amosun (2016:46) affirms that the Geography room is crucial in that special tables and chairs allow easy spread of computers, and the software during GIS classrooms is a prerequisite. Without the required Geography room, tables, and chairs, as well as a computer and other software used by learners during data analysis, data handling, and data interpretation, it will be ineffective. Any other relevant GIS information should be placed in the Geography room (Amuson, 2016:47).

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3.9 GEOGRAPHY GIS TEACHING IN THE REPUBLIC OF SOUTH AFRICA

In South Africa, the Geographic Information System was first introduced in 2006 at secondary school level from Grades ten to twelve (Clarence–Fincham, 2016:97). It is noted that the introduction of GIS in schools in developing countries and developed countries encountered some challenges, including:

- Lack of or inadequate computer equipment and high cost of hardware and GIS software.
- Lack of teacher training and curriculum material.
- Systematic uses involving the use of innovation in teaching.
- Lack of time required to educate teachers about GIS.
- Insufficient presence of GIS in the secondary school Curriculum.

In South Africa, teachers like learners, experience the following school-related challenges when teaching learners: poor teachers' attitude, poor learners' attitudes, inadequate Learning and Teaching Support Material (LTSM), overcrowding in classrooms (Makhwathana, Mulaudzi & Muthambi, 2021), the language of teaching and learning, absenteeism, frequently changed Geography curriculum, and teachers' qualifications and training that do not correspond with what they teach.

3.9.1 The Teacher's Attitudes towards the Geographical Information System

In real-life situations, every person has his/her attitudes, and these attitudes are learnt during a person's lifetime. Teachers' attitudes are some of the factors that contribute to the learning and teaching process, and teachers are confronted with certain attitudes when teaching the Geographical Information System. These teachers' attitudes often affect the way teachers teach GIS, and this becomes evident when these teachers' attitudes, being positive or negative, affect learners' performance in GIS (Clarens-Fincham et al., 2016:47).

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Onuoha (2014:70) opined that poor attitudes towards the subjects have a negative impact on the learner's performance, and the same teachers with negative attitudes towards the GIS sometimes neglect this section in Geography. As a consequence, learners will develop negative attitudes towards GIS and perform dismally low in the classroom (Onuoha, 2014:72). Amosun (2016:43) states that students' negative attitudes towards GIS are one of the factors causing high learner failure rates in Geography. Eze(2018:14)attests that these poor attitudes by the teachers towards Geography, inadequate explanation of points, inadequate preparation, and poor presentation of geographical features by the teachers contribute to learners' poor performance in GIS.

The teachers who have negative attitudes towards Geography GIS are often reluctant to offer extra classes; they do not teach learners on Saturdays or holidays. To make matters worse, these teachers do not attend studies after school and morning studies; hence, they lack interest, motivation, and passion for learning at heart (Eze, 2018:5). Consequently, these teachers lack commitment towards Geography GIS.

3.9.2 Teacher's Qualifications, Competence and Training

The Geographical Information System in Geography requires qualified Geography teachers. The teacher's qualifications, competence, and training are of paramount importance in the academic performance of learners in Geography GIS in Grades 10 to 12 in the South African Education System. According to the National Department of Education, the teachers who are qualified to teach are required to possess a Bachelor of Education, which is a four-year degree. Alternatively, it is by capping an undergraduate degree with a Post-Graduate Certificate in Education (PGCE). All qualifications, including foreign qualifications, are controlled and managed by the South African Qualifications Authority (SAQA) (DBE, 2011:56).

Additionally, teachers who have a three-year qualification, such as a Secondary Teacher Diploma or Primary Teacher Diploma, are also allowed to teach in South Africa, especially those who come from Bantu Education prior to 1994 (Maduane, 2016:139). In South Africa, any teacher who does not possess the above-mentioned degrees and diplomas is

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classified as underqualified and unqualified. However, foreign nationals who come with the required qualifications from their countries of origin are required by SAQA before being employed to submit their qualifications at their offices for verification and authorisation (DBE, 2011:60).

The challenge facing South Africa, especially in Geography GIS teaching, is the issue of underqualified and unqualified educators; hence, the majority of the teachers are not trained in GIS, as it was only introduced in the 2006 Geography curriculum. According to the Department of Education (2011:70), the majority of teachers who are underqualified and unqualified come from Kwa-Zulu Natal Province. In this province, about 70-85 of the educators employed are unqualified and have only Grade 12 to teach, especially in rural, remote schools. In general, close to 9000 – 10000 educators employed in South Africa are underqualified, and they teach learners in Grades 10 to 12 Geography GIS.

Lack of training and qualifications in GIS and incompetence of teachers to teach effectively are some of the variables that cause a high failure rateof learners in Geography GIS (Maduane, 2016:4). Felix (20121:190) asserts that some Geography teachers lack the training to integrate Geography teaching into the Information and Communication Technology System, and, therefore, the leaners' pass rate is compromised. This incompetence on the part of the teachers in GIS knowledge serves to discourage, disempower, and disadvantage learners who are doing Geography GIS.

According to Maduane(2016:77), the majority of teachers who teach Geography GIS use vernacular and mother tongue when teaching GIS; hence, they are challenged by some concepts used in the content, and this is also attributed to a lack of qualifications and training regarding GIS. Any teacher who does not have adequate knowledge of GIS becomes an obstacle for the learners who are doing GIS. The same teachers cannot help learners to become future geographers with diverse career paths, thus killing the future and the chances of success (Maduane, (2016:78). The author argues that unqualified, underqualified and qualified teachers often have low self-esteem and do not feel comfortable in class, and this creates an atmosphere that is not conducive for the learners. The teacher does not provide learning opportunities for the learners because

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the teacher does not meet the expectations of GIS (Maduane, 2016:76). In the case of GIS, the teachers' incompetence makes it difficult for the learners to understand, and, as such, learners will be the'victims'because of the teachers' lack of knowledge and inability to teach GIS effectively.

3.9.3 The Frequent Changes in Curriculum

The first System of Education was the Bantu Education Act of 1953, which segregated Blacks and Whites in terms of Education. The Bantu Education was inferior, and since its adoption in 1953, Blacks were receiving a different curriculum from Whites. All White people were doing all their subjects in their mother tongue, either in Afrikaans or English. The frequent changes in the curriculum started some years ago. During the time of Bantu education, traditional teaching methods characterised by teacher-centred activities were dominant.

When the first democratic elections were held in 1994, the African National Congress took power, and the curriculum was also changed. The change in the curriculum was meant to give all learners equal opportunities and fair quality education (Gumede, 2016:2). In 1998, the South African Education system introduced the first adoption of our Outcomes-Based Education. This Outcomes-based Education was characterised or underpinned by the Social Construction of knowledge, which encourages a learner-centred type of dynamic learning. The purpose of the learner-centred approach to learning is that learners learn best when they are active participants in learning development. All subjects, including Geography, were changed to active subjects as part of the new Outcomes-based Education (Tshiredo, 2013:9).

There were some controversies around implementing the Curriculum 2005 as it was complicated to teach, thus the then Minister of Education, Professor Kader Asmal, recommended that the same curriculum be revised, and after revision, it was then known as the Revised National Curriculum Statement, which was implemented in 2002 (Gumede, 2016:4).

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The Revised National Curriculum Statements were user-friendly since they gave teachers more guidelines and content on what should be taught. In this National Curriculum Statement, the Geographical Information System was included in the map work part of Geography for assessment. The introduction of the National Curriculum Statement forced teachers to change the way they teach, thus adopting learner-centred teaching to all learners; hence, all learners can succeed, but at their own pace and time. This NCS encourages the contextualization of the curriculum because learners are encouraged to solve their own problems in their own settings. The same NCS also gave teachers a headache due to the overload that goes with it, which results in low learners' performance in map work, which includes the GIS (Gumede, 2016:3).

The implementation of OBE and the NCS curriculum in the South African Education System was characterised by different challenges. Those challenges started during the time of Bantu Education, and the same challenges were moving from bad to worse until the newly appointed and the former Minister of Basic Education, Angelina Motshekga, appointed a task team to identify, address, and develop the intervention strategies facing the Basic Education Department (Mukondeleli, 2018:65). The task team appointed by the minister of Basic Education was responsible for, among others, investigating the learners' progression system, continuous assessment, Learners' Teacher Support Material (LTSM), policy guidelines for curriculum, and so forth (Mukondeleli, 2018:72). The findings from the task team appointed by the Minister of Basic Education indicated that there are plenty of policies and guidelines with loopholes. It confuses the teachers who are supposed to implement challenging requirements and overburdens administrative matters, which makes it difficult and complicated for the teachers to impart knowledge in the classroom, and the teacher's training is subject-specific (Gumede 2016:4).

Based on the findings of the task team, the following recommendations were made: the Curriculum and Assessment Policy Statement (CAPS) should be implemented, the administrative work of the teachers, which constitutes the workload, should be minimised, Learners' Teacher Support Materials should be centralised, and reducing the number of learning areas in the Intermediate Phase. The findings and the recommendations from

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the Task Team have led to the development of the Curriculum and Assessment Policy Statement (CAPS) in the South African System of Education. Gumede (2016:5) asserts that the CAPS was implemented in Grades R-3 and Grade 10 in 2012, Grades 4-9, and Grade 11 in 2013, while Grade 12 in 2014.

Based on the above assessment, it is clear that the frequent changes in curriculum, including Geography GIS, have confused the teachers as they have to deal with those changes. The misunderstandings that emanate from many curriculum changes are some of the contributory factors that have led to low learner performance in most Districts of Limpopo Province, including Sekhukhune East District, Limpopo Province. The implementation of CAPS in Education has brought about the following geographical skills, which fall under Geography map work and were known as the GIS syllabus introduced in Grade 12. These skills include but are not limited to data manipulation, data interpretation, data gathering, data analysis, and data handling (DBE Geography Caps, 2011:16).

3.9.4 An Administration of Assessment in Geography GIS

Assessment for learning has the purpose of continuing to collect information on a learners' achievement that can be used to improve their knowledge. It is a systematic way of acquiring the learners' progress and how well the learners are progressing in Geography GIS and in a grade (DBE, 2011:3). This assessment may be formal, informal, diagnostic, summative, and so forth. For formal assessment, tests and examinations come to the fore, and the results from both tests and examinations are used to gauge the learner's performance in a particular subject, for example, Geography.

Geography GIS is taught in the classroom; however, there are some challenges when assessing our learners, especially in Geography. Some authors, such as Innes (2012:94), argue that the system of assessment in the South African Education system is done in an apartheid way. Annes (2012:94) further opines that learners taking Geography subjects wrote two papers.

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The present assessment of Geography as a subject has changed (BDE, 2020:40). The learners who sat for the Geography examination of 2021 wrote Geography papers as follows: Papers 1 and 2 assess both content and map work, which include GIS and were weighted as 150 marks each, while all in all, Geography carries 300 hundred marks. In each paper, 3 hours are allocated, but both papers are written on different days, which is a challenge for learners in terms of preparation and time management because it is written after demanding subjects such as Physical Sciences or even Mathematics. According to the 2022 Diagnostic Report, the learner's performance in GIS was at 43% nationally. This is nevertheless low, but it is not surprising because Geography, with 300 marks, is written on different days.

Geography Papers 1 and 2, which both assess geographical skills and techniques, were the ones under study. According to the Department of Education (2022:76), the geographical skills and techniques are assessed as follows during the end-of-the-year examination in South Africa:

- Marks: 60
- Map skills and calculations (10 marks)
- Map work interpretation (12 marks)
- Geographical Information System (8marks)

The above assessment is also applicable to both Grades ten and eleven. Gumede (2016:50), states that Geography, especially GIS, is related to Mathematics and Mathematical Literacy. As per a circular issued by the Department of Basic Education in 2016, for the learners to pass Mathematics, they need to obtain 40% in Mathematics, but the same circular stipulates that learners who got 20% in Mathematics should progress, thus placing South African Mathematics below par as compared to other African countries.

Some learners who are doing Geographyfind it difficult to interpret, analyse and manipulate data, yet Geography GIS is full of data interpretation, manipulation and analysis, and therefore, it needs learners who are good at Mathematics, Mathematical

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literacy and Physical Sciences to understand (Gumede, 2016:52). Concurring with the above assertions, authors such as Mukondeleli (2018:51) asserts that some learners who are doing Mathematics and Physical Sciences score the worse in the world, and these are the same learners who later have to study Geographymap work which includes GIS, which is close to Mathematics and Sciences. Eventually, these learners will contribute to a high failure rate in map work, including GIS in Geography. One of the worrying factors in the education contexts of South Africa is that millions of rands are spent on education, more than in most countries such as Malawi, Mozambique, Zambia, Nigeria, and so forth, but the results in map work, which includes GIS, are nonetheless low (Mukondeleli, 2018:53).

3.9.5 Learners, Teacher Support Materials, and Other Resources

The Learner Teachers Support Materials (LTSM) include books, computers, software, and so forth. The Learner Teacher Support Materials are critical for the curriculum to be implemented effectively. These Learner Teacher Support Materials in the school context are sometimes referred to as teaching and learning aids used to support teaching and learning. According to Mukondeleli (2018:53), the abundance of learning materials that are GIS-compliant creates a favourable learning environment where learners can be able to take part in the curriculum and enable the learners to achieve their goals.

Mukondeleli (2018:57) indicates that the majority of researchers have observed that the Geography map work, which includes GIS, requires the following support materials: 1:50 000 topographical maps and 1:10 000 orthophotos, computers, software, visual aids, atlases, rulers, satellite images, pencil-printed material and so forth. These Learner Teacher Support Materials (LTSM) contribute to the successful implementation of the learning instruction. In provinces such as Limpopo and Sekhukhune East District, the inadequate supply of the above-mentioned resources is one of the challenges most learners experience when they study GIS.

According to the Limpopo Department of Education LDOE, 2012:8), a provincial monitoring report shows a shortage of books in Grades 8 to 12 in most schools in

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Sekhukhune East District and stationery in some secondary schools. Geography GIS, like map work, is practical, and it needs practical-oriented resources, such as computers and other software. In some schools, buying the required resources is a challenge to most schools, and to some extent, this is a matter of great concern because it leads to learners' low performance. The same challenge is exacerbated by the worn-out and torn-out maps and the replacement thereof (Mukondeleli, 2018:67). The author further argues that in teaching GIS, modern Information and Communication Technologies such as computers and software are critical. GIS is difficult to implement without the availability of proper Learner Teacher Support Materials. As Gumede (2016:7) affirms, most rural schools have no computers, software, or GIS laboratories with well-equipped resources. The fact that there is an inadequate supply of resources in schools, which hampers the quality of education, cannot be ignored and underestimated (Gumede, 2016: 8). Mukondeleli (2018:54) asserts that there is a relationship between learner performance and the quality of resources available to learners in schools.

3.9.6 The Impact of Overcrowding and Class Size on Learner Achievement of GIS

The fact that schools and classes influence learners' performance cannot be underestimated. In South Africa, like most developing countries, overcrowded classes are one of the variables that teachers experience when they teach Geography map work and GIS (Mukondeleli, 2018:54). One of the recommendations from the Department of Basic Education (2011a:67) is that teacher-pupil ratio should be 1:40 in primary schools, while in secondary schools, the ratio should be1:35. Most of the schools have inadequate infrastructure such as classrooms, laboratories, and so forth, and these challenges place teachers at risk for overloading while learners experience the challenge of being unattended most of the time due overcrowding. The overcrowded classrooms hurt, among others, the teaching strategies used by the teachers, discipline among the learners, control and classroom management, and feedback from the teachers (Gumede, 2016:10).

Mukondeleli (2018:54) discoursed that one of the drawbacks of implementing Outcomes-Based Education in South Africa was overcrowded classrooms. For meaningful map

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work and GIS to be taught effectively, the class size should be 1:35, but many teachers teaching Geography map work and GIS face overcrowded classrooms daily, which is one of the causes of learners' low performance. Additionally, crowded classrooms encourage ill-discipline among learners, learners copying from each other, the inability of the learners to move around and stand up, and they also restrict the practical part of GIS (Mukondeleli, 2018:55).

In an overcrowded class, free communication is blocked, and it becomes difficult for the subject teachers to communicate effectively with learners; hence, overcrowding is a barrier. Consequently, overcrowded classrooms are a challenge to assessment because teachers cannot teach and assess effectively if the classroom is overcrowded. The Limpopo Department of Education (2011:11) Report on School Monitoring showed that thirteen schools in Sekhukhune East District had inadequate classrooms. Therefore, overcrowded classrooms in some schools in Sekhukhune East District, Limpopo Province, are of great concern. If not attended to urgently, the learner's academic achievement will be compromised.

According to Breetzke and Pretorius (2011:45), the impediments to the successful integration of Geographical Information Systems in most schools in South Africa include money. The authors emphasised that the lack of funding and financial resources impedes the implementation of GIS education in schools. Kidman and Palmer, as quoted by Mkhize (2020:54), assert that the introduction of computerised GIS in any schooling requires considerable financial input in purchasing the necessary hardware, software, and educational materials, as well as the money for teachers' training. Breetzke and Pretorius (2011:68) further argue that while the problem of funding GIS education is relatively widespread, the situation is exacerbated in South Africa when considering the country's recent political history. The segregationist education policies introduced by the Nationalist government during apartheid, notably the Bantu Education Act of 1953, resulted in a skewed distribution of financial resources in favour of White schools and to the detriment of Black schools. At the peak of apartheid, schools serving White learners had more funding per learner than those serving Black learners (Breetzke& Pretorius, 2011:45).

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Mkhize (2020:63) concurs that the lack of funding and training in South Africa also exacerbates the introduction of GIS education in South African schools. In addition to inadequate financial resources, Mkhize (2020:64) adds that lack of information, inadequate teacher training, and a lack of time for GIS lesson preparation by Geography teachers contribute to the slow and inadequate implementation of GIS in schools. Sumari (2018:3) affirms that financial implications for hardware and software impede the introduction of GIS education in schools across the globe. The author adds that the lack of qualified GIS staff, data limitations, and a lack of awareness of decision matters on GIS also challenge the introduction of GIS education in most schools around the world.

Mkhize (2020:64) states that the lack of GIS training, GIS information by the Geography teachers, financial constraints, and resources exacerbate the successful introduction of GIS in schools globally. According to Breetzke and Pretorius (2011), Sumari (2017) and Mkhize (2020), the lack of computer skills by GIS educators is a challenge because, without computer skills, the acquisition of GIS becomes more difficult for teachers to teach effectively. Toryha Aun (2020) claim that a lack of awareness of GIS, where the majority of educators have no direct contact with GIS, leads to a small probability of selecting the topic as a professional development course catalogue, resulting in a slow introduction to GIS education in most schools.

Manik and Hlatswayo (2021:2) remark that in South Africa, political education instability and curriculum changes are some of the challenges facing the implementation of GIS education in schools. The authors further assert that teachers' perceptions of paper-based GIS, lack of time, infrastructure constraints, data constraints, a lack of funds and support, and rural learning ecology in South Africa worsen and impede the introduction of GIS in most schools.

3.10 METHODS OF TEACHING GIS IN SOUTH AFRICA

A strategy that a teacher uses to present the lesson is known as the teaching strategy. If the teachers use poor teaching strategies, learners will experience difficulties understanding the learning content. A number of authors, such as Nel (2010) and

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Mukondeleli (2018:55), suggest that teaching strategies that were used during Bantu Education teaching methods were teacher-centred and the teacher's role was that of the master of subjects, while the learners acted as the passive recipients of knowledge and information from their teachers. Examples of traditional methods include but are not limited to lecture or telling methods, role learning, drilling methods, question and answer methods, and the memorisation of facts. Mukondeleli (2018:54) further asserts that the traditional methods are a rigid, driven approach, non-negotiable, teacher-centred, and learning responsibilities rest upon the shoulders of the teachers.

After twenty-nine years of democracy in South Africa and the frequent changes in curriculum, the majority of teachers are still using highly teacher-centred methods like lecture and telling methods as methods of instruction. Jacobs et al. (2010:163), in Mukondeleli (2018:55), state that the telling method is the way of teaching in which the teacher delivers an oral presentation about a particular topic to a class. The same author also observed that teaching strategies such as the lecture method are one cause of poor learner achievement in map work and GIS. However, most teachers use this outdated traditional method when teaching Geography, GIS, and map work. The teacher-centred approach minimises the active involvement of learners, and this causes learners to be passive recipients of knowledge instead of active contributors to the learning content. This classical teaching "telling method," where teachers dominate, and the learners are passive listeners, is ineffective for the learners to understand Geography GIS as well as Geography map work because Geography GIS, like Geography Map work, requires learners to be active participants in the classroom (Mukondeleli, 2018:56).

Gumede (2016:11) affirms that many teachers teaching Geography GIS are caught in the traditional methods where the teacher talks and the learners listen. In some schools, many learners are taught GIS and map work when they are left with some weeks to sit for their examinations by discussing the previous question papers for GIS. This encourages cram work and reproduction of facts in their examinations.

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3.10.2 Learners' Attitudes towards GIS

The learners' attitudes towards GIS are one of the variables that the same learners experience when they study the Geography GIS in the classroom. The negative attitude towards GIS is of great concern. The above views were supported by the Geography Diagnostic Report NSC (2022:141), which points out that some learners are ignorant since the majority of them do not answer some of the questions based on GIS.

According to Mukondeleli (2018:46), the key to learning Geography GIS also depends on the motivational level of the learners. Motivation, being intrinsic, is regarded as the driving force behind understanding and learning Geography map work and GIS. In learning Geographymap work and GIS, learners should have a sense of value to participate in the subject, and if the sense of value is not obtained, it turns out to be a barrier for the learners to continue to learn Geography GIS (Mukondeleli, 2018:46).

Mohammed et al. (2020:51) revealed that learners' poor attitudes towards GIS and their mathematical background deficiency make it challenging for the same learners to comprehend Geography map work and GIS, respectively. Mukondeleli (2018:47) concurs that learners with low self-esteem describe themselves as lazy and unable to do their work, slow, dumb, and irresponsible, and perform poorly in Geography GIS and Geography map work. These negative views also negatively influence themselves and their academic achievement in Geography map work and GIS. Low self-esteem, negative attitudes, and lack of motivation are prominent variables that challenge learners to achieve academically in GIS. The author further observed that learners who fail to make their own notes are expected to perform poorly in Geography GIS. As a result, negative attitudes towards Geography map work and GIS (Mukondeleli, 2018:47).

3.11 STRATEGIES THAT CAN BE ADOPTED TO TEACH GEOGRAPHY GIS IN SOUTH AFRICA

Since the dawn of democracy, the introduction of Outcome-based Education in the South African education system has necessitated the introduction of the social construction

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teaching approach. According to the OBE and social constructivist teaching approach, learner-centred and active participation in constructing knowledge is paramount. Against their background, this section deals with learner-centred strategies deemed suitable for teaching Geography GIS. These include, but are not limited to, the following:

3.11.1 Laboratory Method

According to Felix (2021), Geography GIS is taught like science subjects using the laboratory method. This means the teacher carries out an experiment where the teacher demonstrates an experiment, and the learners will follow it, whereas the completion will be to prepare a chart model and maps. This means that learners are not merely listeners but are compelled to observe and perform the experiment on their own to make sure Geography concepts are transparent (Mohammed et al., 2020:4).

Mikanjuala and Sadig (2013:2) avow that using the laboratory method means learners translate what they see and read in Geography realities. In doing so, learners' understanding is enhanced, and they can further recall what they see more than what they hear. Laboratory work is vital for Geography because there is no opportunity for deliberate observation of the geographical phenomenon (Felix, 2021:58).

The integration and the use of ICT in the laboratory method are claimed to promote collaborative learning, participative learning, and explorative learning (Mukondeleli, 2018:50). Felix (2021:50) added that the laboratory method promotes academic discipline because it engages learners throughout the lesson, hence active participation is central to this type of learning. The Geography teacher can display photographs, satellite images, and graphs of Geography phenomena on the internet and YouTube for specific topics of Geography and develop questions around the profile for the learners.

3.11.2 The Reduction of Class Size

Hlatswayo and Manik (2021:337) argue that another factor that improves the learners' achievement is the reduction of class size. These proponents of smaller class sizes, such

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as Hlatswayo and Manik (2021:337), assert that smaller classes provide a higher quality of learning opportunities, the development of teacher-learner relationships and learner centred training, increased teacher morale, and fewer cases of student misbehaviour. For example, in the GIS classroom, enough space is needed for maps and satellite images, and this small class size is very important for the learners to work in groups to share ideas and solve geographical problems. In classrooms with small learners, teachers use more learners-centred teaching approaches and promote individualised learner support for learning than when classrooms are large (Hlatswayo & Manic 2021:338). Mukondeleli (2018:46) concurs that small class size encourages cooperative learning, especially when learners learn Geography map work, which includes GIS, and this increases collaboration among the learners when they share concepts in groups and work together to solve a challenge, for example, a project on GIS.

Hlatswayo and Manik (2021:338) elaborate that class size reduction should be done in conjunction with other measures to achieve the greatest impact, for example, teaching methods, classroom management, and in-service training. Simply reducing class size as a method without enough skilled teachers or simply reducing the class size has no significant impact on making a difference. In this study, reducing the class size is suitable for GIS because small-sized classrooms give the teachers the opportunity to work with small groups and provide individual attention, especially for slow learners. In GIS lessons, the topographical and orthophotography maps need a large space; therefore, it is vital for teachers to work with a small group of learners (Mkhongi & Musakwa, 2020:2).

3.11.3 Collaborative or Group Teaching Strategy

Felix (2021:56) states that group work or cooperative learning is an instructional method that gets students to work together in groups on a specific Geographical topic. Mukondeleli (2018:61) asserts that collaborative methods include learners sharing concepts in groups and working together to resolve challenges, for example, projects and fieldwork. The purpose of group work is to encourage learners to work together towards a common goal. Therefore, teachers need to design social interaction structures and

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learning activities to maximise their own and each other's learning (Mukondeleli, 2018; Felix, 2021; Mkhongi & Musakwa, 2020).

The advantages of group work or collaborative strategies, as opined by Felix (2021) and Mukondeleli (2018), in the Geography classroom are as follows:

- It breaks complex tasks into two parts and steps.
- Refine understanding through discussion and explanation.
- Give and receive feedback on performance.
- Develop stronger communication skills.
- It challenges assumptions.

Mukondelleli (2018:62) advises that in collaboration, learners work in groups to elucidate problems. The learners can share learning strategies through social interaction. The key benefit of cooperation among learners is that peers become resources in the learning process and further promote collaborative philosophy. In collaboration learning, Mukondeleli (2018:67) shares that there is a connection among learners, and they vigorously interchange ideas, critique each other's work, and negotiate meaning together in an atmosphere of intellectual honesty. In this study, a collaborative or group work teaching strategy is suitable for doing GIS work. GIS requires learners to work as peers to construct knowledge, whilst working on data analysis, manipulation and interpretation when identifying the polygons, lines and point features on the maps (Felix, 2021:54).

3.11.4 The Development of Human Resources Capacity

Mkhongi (2020:25) asserts a solution by stating that the learning of Geography can be enhanced by creating GIS resources, being supportive of the leaders of GIS education, and further building capacity within the Geography community, researchers, and educators, because these people are the GIS instructors in classrooms. According to BluDoT (2018:50), teachers must be convinced to use technology in the classroom; educators must be provided with strong guidance and support, such as technology-integrated pedagogy and content-specific examples of technology capacity within the

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lesson plans. Fleischmann and Van der Westhuizen (2017:15) affirm that education in the twenty-first century demonstrates a learner-centred approach that can be supported by using GIS as a teaching tool, for example, the Interactive-GIS Tutor (IGIST), which is a solution that enables educators to connect a digital projector to a laptop or computer for teaching. Fleming (2015:51) echoed Van der Westhuizen's sentiment (2017:15) by stating that GIS resource development, teacher training, and GIS camps are good interventions for improving GIS in education.

In the Western Cape, the South District proved the latter intervention to be effective because the teachers camps hosted by the University of Pretoria contributed to Geography results improving by 6% (Mkhongi, 2020:26). During these camps, 30 learners from the previously disadvantaged areas of South Africa, together with ten visiting Americans students, had an opportunity to engage with geo-technologies. The success of the Metro with the South District shows how the collaboration of different stakeholders can improve the understanding and practice of GIS education (Mkhongi, 2020:27).

3.11.5 The Paper-Based Teaching Strategy

Fleischmann (2012:41) emphasised that schools can adopt GIS education offering paper-based, which is supported by ISRI South Africa (Pty) Ltd and maintained by the Department of Geography, Geo-informatics and Meteorology at the University of Pretoria (UP). Such a method can offer a convenient solution for schools, especially those with fewer electric resources and or computers available to learners.

3.11.6 GIS Science Teaching Strategy

Mkhongi (2020:28) reveals that another significant strategy for improving GIS education is to go on the path towards Geographical Information Science (GIScience). Felix (2021:35) emphasises the need to pay attention to GI-Science because this science strives to answer fundamental questions that relate to the use of GIS. Hence, GI-Science is the central element in supporting spatial analysis. According to Mkhongi (2020:28),

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GI-Science studies the theoretical and empirical principles related to GIS as well as how these are implemented and expressed in GIS. Since reasonably sophisticated technology like remote seeing software, GIS, GP receivers in the field, cartography, as well as geospatial data sets and imagination (Mkhongi, 2020:28), GI-Science could enhance learner and educator spatial thinking capabilities and thus the advancement of GIS Education.

3.11.7 The Use of Item and Error Analysis

According to Leepo (2015:91), the use of Item and error analysis helps teachers to identify errors and incorrect actions, describe how to correct mistakes or improve on mistakes or inappropriate actions, and move swiftly to the grafting of the improvement plan. Error analysis is the examination or investigation of errors that learners make that have a negative impact on the process of learning. The error analysis informs the teachers about what the learners have already mastered and what they are struggling with.

According to the Department of Basic Education (2013:13), it is expected that subject teachers sample not less than 10% of the learners' scripts in the test or examination, identify errors that learners consistently commit, and analyse the errors before coming up with the ways and means of solving them. The subject teachers then look up the most appropriate and simplified ways of problem-solving so that the learners master the concepts and can solve similar or related problems (Leepo, 2015:91). This helps the subject teachers to improve the teaching methods and additionally allows the teachers to employ a differentiated teaching approach according to the learner's cognitive level and needs.

It is through the use of item and error analysis that the subject teachers are empowered to understand the learners' thinking process. The errors may result from the misunderstanding of what the teachers have taught or ineffective teaching methods used by the teacher (Leepo, 2015.92). Lepoo (2015:92) adds that the errors committed by the learners provide the teachers with rich information that they can use to improve their teaching strategies and interventions. Errors that occur during the teaching process are

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detected and corrected. Having done the item and error analysis, an improvement is developed by the subject teachers, aiming to monitor the work of the teacher with the purpose of helping the learners who are at risk of failing.

3.11.8 The Use of Information and Communication Technology (ICT)

According to Ncube (2018:22), traditional lecture methods in Geography must be replaced by learner-centred, collaborative, and spatial thinking learning, and because of this paradigm shift, it is necessary to produce a table that shares a shift from traditional learning to a new paradigm in Geography teaching which has adopted the use of ICT in the teaching Geography, especially in GIS. Felix (2021:64) declares that ICT can raise the geographical and educational quality and connect learning to real situations. Since learning is an ongoing activity where learners change their expectations by seeking knowledge, using ICT will be an indispensable prerequisite for these learners in developing geographical skills (Felix, 2021:64).

Ncube (2018:24) opined that the value of ICT is that it supports student-centred and self-directed learning. Student-centred learning is described as the shift in power from the expert teacher to a student centre, driven by the need for a change in the traditional environment with one teacher (Felix, 2021:65). The interactive user-centred, open structure of the new ICT's ideal for the student centred and self-directed learning for Geography Information Processing (IP) learners, and learners' interaction with ICT can enhance their self-directed Geography skills. The style of teaching Geography gives students more freedom in choosing their way of learning by using ICT as the primary self-directed learning tool (Felix, 2021:66).

Ncube (2018:25) affirms that when students use ICT frequently, they build new geographical knowledge through answering, selecting, organising, and interpreting information and data. A student-centred ICT classroom requires skills to deepen the learners' understanding of the environment and spatial relationships (Felix, 2021:66). Ncube (2018) and Fleischmann (2012) provided the following reasons why ICT improves student-centred and self-directed learning in Geography.

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- ICT helps learners to process information easily and fast.
- Produce dynamic images to represent relationships.
- ICT gives learners immediate access to richer source material, and
- ICT helps learners access a wide range of up-to-date information sources.

Mkhongi (2020:54) claims that ICT produces a creative and flexible learning environment that enables learners to access all types of textbooks from the beginning to advanced levels with ease through computers, laptops, and personal digital assistants. Felix (2021:67) elaborates that where teachers and learners are engaged in a creative environment, it will lead to authentic and deep learning, which will have a more encouraging geographical outcome. New technologies will promote creative learning and important teaching tools and teach creatively in Geography (Ncube, 2018:26).

Fleischmann (2012) and Felix (2021) posit that ICT promotes collaborative learning in a distance learning environment. Distance learning environment is a teaching and learning system specifically defined and is carried out remotely using ICT where students are required to do different online activities (Felix, 2021:69). Geography learners can work collaboratively to do a research project using ICT, and this increases the geographical skills because learners share, communicate and work collaboratively in a distance learning environment. Geography learners may have the opportunity to analyse problems, explore ideas, and develop concepts remotely (Mkhongi, 2020:27). Felix (2021:69) reveals that ICT offers more opportunities for learners to develop critical thinking skills, which involve the learning of complex judgemental and problem-solving when students encounter unfamiliar issues.

Through the use of ICT, students become knowledge constructors rather than knowledge users. Mkhongi (2020:30) states that one of the advantages of using ICT, like Google Earth, over traditional means is that it is obvious in building higher-order thinking skills in spatial thinking.

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According to Leepo (2015:98), the integration of ICT into the curriculum allows learners to develop skills that will give them an edge in an increasingly technology-saturated work environment. The introduction of ICT in the curriculum allows learners to become creators of knowledge in their own right, for example, through conducting research for a school project on the internet and then having to produce, say, a PowerPoint presentation. Learners who use ICT in their assignments and projects begin to cultivate a culture of personal information, management, independent thinking and working without supervision, communication skills, teamwork and research skills (Leepo, 2015:97).

3.11.9 Fieldwork Teaching Strategy

According to Firomumwe (2019:1), fieldwork is one of the traditional approaches adopted in holding instrumental approaches in the field of Geography. The author further states that fieldwork directs and exposes learners to the outside of nature. Fieldworkis is relevant to teaching Geography GIS because the learners learn and discuss in groups; hence, what is learnt outside the classroom cannot be easily forgotten (Firomumwe, 2019:13). In teaching GIS, learners can be led to direct experience of among others, lines that represent rivers; polygons that represent cultivate lands, and points that may represent towns or activities. Through fieldwork, learners can relate lines with GIS features such as slopes, rivers and roads.

Practically, Geography GIS allows learners to discover learning independently, and this leads to the development of critical thinking skills, independent thinking skills, and analytical skills. Mukondeleli (2018:67) indicates that fieldwork enables the learners to create a real-life learning opportunity, enabling the same learners to get immediate information from the environment. Hence, fieldwork covers both classroom and outdoor activities. Learners are outside to have direct experience and experiment on geographical features that are GIS related, such as satellite images such as the stadiums, lines data such as roads, polygons such as land use zones, coastal rivers and location of features such as X and Y. Additionally, fieldwork allows learners to come into contact with GIS features such as the drainage basin, its length, the stream order, sediments load and river discharge (Mukondeleli, 2018:67).

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3.11.10 Discussion Teaching Strategy

According to Taat (2018:1), the discussion could be considered an activity that involves the written or oral expression of different points of view in a given situation. The same author defined a discussion as an ultimately serious and playful effort by a group of two or more to share views and engage in a mutual and reciprocal critique. When teachers use the discussion teaching strategy, teachers can take ample time to think critically about the topic in GIS, such as identifying the spatial, raster, and vector attribute data on the topographical or orthophotography map. Consequently, the teachers need to plan the discussion beforehand and inform the learners about the aims and the intended objectives. In any discussion, the role of the teacher and learners is clarified and spelled out by the leader of the discussion, that is, the teacher.

The teachers' work is to lead the discussion in the right direction, permitting learners to exercise their responsibilities, duties, and authority as group leaders and members of the discussion groups (Mukondeleli, 2018:68). Taat (2018:3) admits that discussion approaches are appropriate for several objectives, which include providing the teacher feedback about learners' learning higher-order cognitive skills such as application, analysis, synthesis, and evaluation. These approaches also help the student develop their interest and values and change attitudes, as well as allow students to become more active contributors to their own learning (Taat, 2018:3).

Mukondeleli (2018:68) posits that when using the discussion style of teaching, learners gain knowledge, as they will be sharing different experiences, which gives the teachers an opportunity to work with learners at different levels simultaneously. The author further argues that in the discussion style of teaching, the teachers assist the learners in grasping GIS topics and, at the same time, discuss the map work and GIS topics with the aid of the teachers.

Taat (2018:3) affirms that the main reason students choose the discussion method is that learners are active, engaging in discussion rather than sitting passively in class and merely listening to the lecture. The same author shares that it is useful for the teacher to

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allocate enough time for individual reflection before a group discussion takes place. Individual reflection, as Taat (2018:2) suggests, may increase the diversity of opinions among the groups and decrease the tendency for the groups to take a single track throughout in relation to the questions forwarded by the lecture.

3.11.11 Delivery of Enrichment Classes

According to Leepo (2015:99), enrichment classes include school holiday classes, Saturday classes, learning centres, and incubation and matric camps. Leepo (2015:99) further asserts that education districts should embark on these intervention programmes to deal with the challenging topics that learners struggle to comprehend and master during the regular teaching periods. In most cases, these intervention programmes focus only on the gateway subjects such as Mathematics, Physical Science, Geography, Life Sciences, and others. Maduance (2016:76) described enrichment classes as enabling teachers to identify learners with learning difficulties, and in these camps, teachers can assist those learners who are underperforming in different gateway subjects.

Leepo (2015) posits that in enrichment classes, students are exposed to different teaching styles that do not involve memorising and note-taking, and the same learners are exposed to a wide variety of knowledge beyond academics. Enrichment classes complement classroom teaching, and children attending enrichment programmes have improved social skills, and students improve grades and career opportunities (Leepo, 2015:99).

3.11.12 Project-based Teaching Strategy

The project is a learner-centred activity that is done outside the classroom by the learners and is presented in real life. According to Kim (2018:1), Project-Based Learning (PBL) is defined as a student-driven (student-centred) approach to learning in which students are required to take part in a real project by developing a question or inquiry and under the supervision of the teachers to create a project to share with a selected audience. In a project, learners work individually or in groups to gather GIS information.

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In Geography's theoretical part, the project or research is part of the assessment task written by the learners from Grades ten to twelve in Term 2 before the commencement of May/June Examinations. This project-based learning involves data analysis, data interpretation, and data manipulation skills needed from learners. When planning a GIS project, the teachers should clearly define the intended objectives to be attained, a specific time, and relevant resources and sources to be consulted (Mukondeleli, 2018:70). Kim (2018:2) opined that the importance of the project method in the teaching of Geography is as follows:

- It helps students to solve problems.
- It encourages students to work collaboratively and amicably in groups.
- It enables the students to be alert and active.
- It encourages members to make contributions.
- The teacher's role is to guide, friend, philosopher, facilitator and mediator.
- The teacher also learns something during the execution of the project (Kim 2018:2).

3.11.13 Inclusive and Differentiation Teaching Strategy

According to Kirschner (2015:1), inclusive education refers to an educational system designed to ensure access for all groups that have been marginalised in society and schools. Mukondeleli (2018:59) defined inclusive teaching as a learning environment that endorses all learners' full personal, academic, and professional development, regardless of their gender, religious convictions, culture, sexual preferences, and learning style. In essence, inclusive education allows everybody to take an active part in the general public and also in education on an equal basis. This also means that when a teacher teaches Geography GIS, the same teacher should accommodate all learners, irrespective of their learning disabilities and difficulties in the lesson preparation and presentation, to assist them. Teachers are confronted with learners' challenges such as physical barriers, hearing loss, visual impairment, mental challenges, and psychological barriers, and most of these challenges are faced by teachers when teaching Geography

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GIS in Sekhukhune East District. Before, learners with impairments were excluded from doing Geography in general and map work in particular (Mukondeleli, 2018:62).

Kirscher (2015:2) avows that schools are forced by the laws to allow every learner to take part in curriculum matters, and the teachers are forced to adopt a diversity of strategies to support and teach learners with diverse learning disabilities. These strategies may include project methods, cooperative learning, and problem-solving so that learners can work independently and peacefully to achieve their learning objectives.

On the other hand, teachers can use differentiation, where learners are taught according to their special needs to accommodate their learning and differentiated needs. Additionally, the teacher can implement inclusive education through adapted lessons and tasks, specialised training, and diverse methods of working and supplementing materials that are used for teaching and learning (Hughes & McDuff, 2019:5). The authors advise that inclusive education may take different forms: mainstreaming, partial, and complete inclusion. Consequently, inclusive education can be achieved through appropriate curriculum, ensuring quality education to all, cooperative multi-level teaching and learning, and parental involvement (Arksela & Markula, 2022:1). According to Hughes and MCDuff (2019:5) in every classroom learners with different abilities should be catered; therefore it is vital for the teachers to teach these learners taking in to consideration all diverse form of abilities hence all learners can succeed but not in the same time and pace. In teaching Geography mapwork, which includes GIS, learners should be grouped according to their abilities and diversity and be taught using a differentiated approach when working on satellite images (Hughes & McDuff, 2019:20).

3.12 CONCLUSION

Findings from the literature review revealed that there are major challenges experienced by learners and teachers when teaching and studying Geography GIS. These challenges were discussed from the international, African, and South African perspectives. The countries studied are Turkey, a developed country, Nigeria, and the Republic of South Africa, which are developing countries. All challenges experienced by the teachers

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teaching and learners doing Geography GIS in these selected countries. The literature has shown that it is important for teachers to develop and identify teaching strategies in Geography GIS that can improve learners' low performance. Finally, the same literature discussed some of the teaching strategies that can be adopted by Geography GIS teachers in the South African context.

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CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

This chapter provides the research paradigm, research design, and methodology used in the study. This chapter also outlines the research design, research methodology, and sampling. In this section, measures of quality control, which include transferability, dependability, trustworthiness, and credibility, as well as the data collection techniques of the study, were also discussed.

4.2 RESEARCH PARADIGM

Research paradigm refers to the theoretical way of thinking. In education, research paradigm refers to the researcher's worldview, a comprehensive belief system, worldviews, or framework that guide the researcher and practice in the field (Oui, 2019:2). Maree (2019:383) posits that a paradigm serves as a lens or organising principle by which reality is interpreted, whilst McMillan and Schumacher (2010:50) assert that research paradigms are categorised into: anti-positivism, critical or transformative, interpretivism, and pragmatic paradigms. Pham (2018:3) states that a paradigm implies the philosophical position of the researchers about the nature of the matter, what can be known, and how knowledge can be attained. Pham (2018:4) shares that paradigms consist of two components: the belief about the nature of knowledge and the methodology and criteria for validity. In this study, the researcher adopted the interpretivism paradigm. According to Mokhtar (2022:4), the interpretive paradigm is based on the principle that reality is socially constructed through the experiences of social narrators, and it is rooted in the fact that methods used to understand knowledge relate to human and social scenes. Maree (2019:20) concurred that the interpretive paradigm is based on the assumptions that human life can be understood from which people construct the social world by sharing meanings, experiences, and how people interact or relate to one

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another; social life is distinctively human, meaning reality is not objectively determined but socially constructed.

The interpretive paradigm is concerned with understanding the world as it is from the subjective experiences of the individuals (Maree, 2019:20). Pham (2018:7) avows that the advantage of the interpretive paradigm is that it believes in diversifying views to investigate the phenomenon and understand humanism in a social context. This study investigates the views of geography curriculum advisors, geography learners, and geography teachers on GIS in their own settings. That is why the interpretivist paradigm is suitable.

4.3 RESEARCH DESIGN

A research design is the conceptual blueprint within which research is conducted (Mokhtar, 2022:6). Maree (2019:97) outlines aresearch design as a "set of guidelines and instruction to be followed in addressing the research problems and the purpose of the research design is to specify a plan for generating the empirical evidence that will be used to answer the question." According to McMillan and Schumacher (2010:20), research designs are classified into four major categories: qualitative, quantitative, mixed approaches, and analytical design.

A qualitative research design was used for this study. The qualitative research approach is a procedure of explanatory enquiry in which the researchers interpret what they see, hear, and understand (Maree, 2019:71). The qualitative approach also puts a great emphasis on the merit of the units and meanings that are not experimentally examined in terms of quantity. Qualitative approaches also refer to the definition, characteristics, and description of things (Cresswell, 2013:123).

According to Maree (2019:92), the qualitative approach also uses a case study; hence, individuals will be studied in their environment. A case study is an intensive, holistic description and analysis of a single entity, phenomenon, or social unit. In this study, the researcher was interested in the meaning, understanding, and integration of the research

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problem relating to enhancing strategies to improve learners' performance concerning Geographical Information Systems. The researcher opted for a qualitative case study design to gain an in-depth understanding of the situation surrounding the exploration of suitable strategies by teachers and curriculum advisors to improve learners' performance of GIS in the Further Education and Training (FET) Phase. The main characteristics of qualitative research are that it is usually appropriate for small samples, while its outcomes are measurable and quantifiable. Its basic advantage is that it offers a complete description and analysis of the scope of the research and the nature of the participants' responses (Mokhtar, 2022:115). The purpose of the research design, as stated by McMillan and Schumacher (2010), Pham (2018), and Maree (2019), is to achieve greater control of the study and improve the validity by examining the research problem.

4.4 RESEARCH METHODOLOGY

McMillan and Schumacher (2010:190) define research methodology as the theory of how an enquiry should proceed. It involves the analysis of assumptions, principles, and procedures using a particular enquiry approach. Maree(2019:91) posits that research methodology is a term for the structural research process. A research methodology seeks to inform why the research study has been undertaken, how the research problem has been defined, in what way and why the hypothesis has been formulated, what data have been collected and what particular method has been adopted, why a technique of analysing data has been used (Langos, 2014:2).

Authors such as Rehman (2016:24), Maree (2019:91), McMillan and Schumacher (2010:50) state that research methodologies are classified into three categories: qualitative methods, quantitative methods, and mixed methods. In this study, qualitative research methodologies such as interviews, observations, and document analysis were adapted to probe a deeper understanding of the responses given by the interviewees and help untangle complex topics (Maree, 2019:72).

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4.5 POPULATION AND SAMPLING

The following is a brief discussion of population and sampling.

4.5.1 Population

A population is a group of elements or cases, whether individuals, subjects, or events, that conform to specific areas and which we intend to generalise the research results (McMillan & Schumacher, 2010:129).

4.5.2 Sampling

The study population was the Geography curriculum advisors, Geography teachers, and Geography learners. The reason behind the selection of purposeful sampling was that it enabled the researcher to select the sample based on the study's purpose and the population's knowledge. Participants were chosen due to their understanding of Geography (Mukondeleli, 2018:13).

This section involves the selection and identification of the population, the determination of the sampling procedure, and the sample.

4.5.3 Sample and sampling procedure

This study adopted qualitative sampling, such as purposeful sampling, to select the participants. Purposeful sampling refers to using the researcher’s knowledge to meet the researcher’s objectives (Mokhtari, 2022:73).

4.5.4 Sample

Maree (2019:91) defined a sample as a group of subjects from whom data is collected, often representative of a specific population. A sample is done to determine the research's accuracy and collect rich data. According to McMillian and Schumacher

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(2010:64), sampling methods are classified into two groups, namely, probability samples such as simple random sampling, systematic sampling, stratified sampling, and cluster sampling, and non-probability samplings such as convenience sampling, quota sampling, snowball sampling, and purposeful sampling, which is commonly used in an educational setting. A non-probability sampling, such as purposeful sampling, was adopted to select the participants for this study. Furthermore, purposeful sampling was adopted because the participants represented the characteristics that were of interest to the research topic at hand (Maree, 2019:87). Consequently, in purposeful sampling, the researcher makes a judgement regarding which participants should be selected (Cresswell, 2013:54). The sample in this study consisted of fifteen respondents: three Geography curriculum advisors, six Geography teachers, and six Geography learners selected from three schools in three Circuits in Sekhukhune East district, Limpopo Province. In each school and circuit, two teachers and two learners were selected. Hence, the sample consists of fifteen respondents. In this district, there is a total of 244 secondary schools.

4.6 DATA COLLECTION STRATEGIES

This study collected data through interviews, observations, and document analysis.

4.6.1 Interviews

According to Maree (2019:108), an interview is a two-way conversation in which the interviewer asks the participants questions to collect data and to learn about the ideas, beliefs, views, opinions, and behaviour of the participants. Maree (2019:108) further states that the purpose of qualitative interviews is to see the world through the eyes of the participants, and they can be a valuable source of information provided they are used correctly. The researcher took a month to conduct interviews with the selected participants, and this was done by writing to transcribe, review, and ask additional questions at the end of the interview. Permission from the participants was obtained before the interviews (Cresswell, 2013:212). For the purposes of this study, fifteen respondents were interviewed, and Geography curriculum advisors and Geography teachers answered the main research question. The saturation was reached when all the

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respondents repeatedly provided the same answers as previously given, and nothing new was coming. The data already collected was sufficient to draw the necessary conclusions, and collecting any further data wouldn't have produced any value-added insight.

4.6.2 Justification for the Use of Interviews

Kali (2005), McMillian and Schumacher (2010) and Maree (2019) claim that the advantages of using interviews are as follows:

- They are flexible and allow the interviewer to adapt to each respondent's situation.

- They allow for the gathering of more in-depth data. Cresswell (2013:45) adds that when interviews are conducted, they can produce in-depth data, which is impossible to get with questionnaires.

- They allow for probing. Interviews provide opportunities to secure additional information by asking additional questions when the respondents answer unclearly and off the mark.

- They allow for rapport to be established since an interview is a two-way person interaction method of data gathering; they can establish a rapport and a relationship of trust, making it possible for the interviewers to get a response, which is impossible in questionnaires.

- They allow for new directions to be explored. The flexibility of the interview enables the researcher to pursue a given lead to gain insight into the problem and obtain more adequate answers.

- They permit additional data gathering by observation. In addition, interviewers who see a person interview secure information through observation.

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- They facilitate the gathering of data to express in writing. According to Maree (2019), interviews allow for examination-laden information that differs from what is described in writing.

- They allow the researchers better control over data-gathering procedures. Unlikely the questionnaires, which are not in the hands of the researcher until the moment they are sent, interviews allow the researcher to remain in command throughout the entire situation (Kali, 2005:27).

They obtain better response rates. With the researcher personally administering the tool, a great percentage of returns is promoted, and this can increase the validity of the results. Observation as a data collection strategy.

According to Maree (2019:105), observation is the systematic process of recording the behavioural patterns of participants, objects, and occurrences without questioning or communicating with them. The purpose of observation is to enable the researcher to gain a deeper insight into and understand the observed phenomenon. Observation allows the researcher to hear, see, and experience reality as the participants do (McMillan & Schumacher, 2010:35). The authors further assert that observation is categorised into a complete observer, observer, observer as the participant and complete participants. The purpose of observation is to gather information and gain a deeper understanding of how the teachers teach in their own environment in order to inform decisions, solve problems or develop curriculum (McMillan & Schumacher, 2010:38).

A classroom observation schedule

1. Which strategies do teachers use to teach Geographic Information Systems?
2. Which teaching competence do teachers display when teaching Geographical Information Systems?
3. What are the tools teachers use when teaching Geographical Information Systems?

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This study adopted the complete observer, sometimes called a non-participant observer, because it is the least obtrusive observation form. A period was spent in selected schools, where a checklist and field notes were used to observe teachers while teaching Geographical Information Systems to learners. The researcher used field notes to record information about how learners were copying and possibly the problem that they were experiencing. Observing the teacher's teaching was suitable for gathering information about the GIS experience of the learners in their natural setting. The context in which the GIS problem occurred was observed to gain some understanding of the demands related to the exact Geographical Information System. According to McMillian and Schumacher (2010:36), using observational methods can be advantageous rather than relying on the subject's responses to questions; these methods rely on the researcher's perception and recording of the observation.

4.6.3 Justification for the Use of Observation as a Data-Gathering Strategy

McMillian and Schumacher (2010), Maree (2019) and Kumar (2022) assert that the advantages of observation are as follows:

- It is direct and helps to study the behaviour as it appears/occurs.
- Data collected in the natural environment or situation is reliable.
- The data may be much more accurate as it is collected from intimate and informal relationships.
- It is one of the best methods that can be adopted when people cannot state meaningfully, e.g., studies about children, tribes, animals, etc.
- It helps to study the whole event and, therefore, may provide the opportunity to study the insights or all aspects.
- It helps to collect data when the respondent is unwilling to cooperate in giving information.
- It is expensive, but collecting data on emotional reactions is also possible.
- It also helps to analyse the constitutional background.

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4.6.4 Document Analysis

Maree (2019:100) shares that documents include, but are not limited to, diagnostic reports, textual books, and mark schedules that are used to gather data during the research process. In the study, the researcher used a mark schedule to collect data about learners' performances in GIS. Additionally, the Diagnostic Report for 2022 and the previous years were adapted to identify the problems learners experienced when answering questions on GIS and the general learners' performance for Geography, in general, and GIS, in particular. Consequently, items and error analysis compiled by the Geography Team from the Department of Basic Education were also adopted to identify the errors that learners commit when answering questions about GIS. In doing document analysis, the researcher tries to find out the lesson plans, the Annual Teaching Plans (ATPs), the Program of Assessment (POA), ICT and Learner Teacher Support Materials that are GIS compliant. This method answered this question: What ICT materials do teachers use to enhance learners' performance in GIS?

4.7 DATA COLLECTION PROCEDURES

The researcher had sought permission from the University of Venda Research Ethics Committee for an ethical clearance certificate and ethical clearance. Permission to conduct the research was sought from the Limpopo Department of Education, Sekhukhune East District, Circuit managers, and school Principals. Consequently, consent and assent forms were distributed to the parents. The researcher delivered the consent forms to the identified schools after permission was granted by the school principals. An interview with the curriculum advisors was arranged, involving Geography teachers and learners. Assent forms for minor learners were distributed to their parents.

4.7.1 Data Analysis

According to McMillian and Schumacher (2010:264), data analysis is the recurring procedure incorporated into all research stages. This process brings structure and meaning to the mass of collected data. This study adopted the Thematic Analysis (TA)

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method of data analysis to analyse the collected data. The thematic analysis is a technique for identifying, analysing and reporting patterns (themes) within the data (Maree, 2019:77). Aronson (2005:63) indicated that the objective of Thematic Analysis is to produce key themes about the understanding of the participants and due to its flexibility; Thematic Analysis is used in case studies. The author added that Thematic Analysis provides core skills for conducting many kinds of analysis.

4.7.2 Development of the Coding System

A coding system is created when the respondent's information and questions are translated and then divided into two categories: On the interview transcripts, all quotes containing information will be highlighted (Kali, 2005:23). Codes for different categories were created. In this study, data were analysed constructively based on the interpretivism philosophy aimed at examining meaningful symbolic content and allowing the research findings to emerge from the themes. In this regard, content analysis was adopted for this study. Kali (2005:24) shares that Thematic Analysis is one of the common forms of qualitative research that emphasises identifying and interpreting patterns of meaning or themes within the qualitative and is used to address different research questions.

Maree (2019:68) notes that data analysis aims to pick up problems in the data collection methods and identify possible challenges in the analysis process. The author further states that in Thematic Analysis, the researcher codes the data by applying Content Analysis to look for specific words to identify themes. The researcher used Thematic Analysis because it is hypothetically flexible and capable of detecting and identifying factors and variables that influence any matter guaranteed by the participants (Pham, 2018:77).

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1.8 MEASURE OF QUALITY CONTROL

4.8.1 Credibility

When a conclusion corresponds with the state of reality, this is referred to as credibility. For example, when a ruler is used to measure length and distance, then the results may be valid. In research, validity is evident when the researchers' conclusions correspond with the state of reality (Maree, 2019: 67). When conclusions in the research are based on the data collected, the process is called credibility. In this study, credibility was established by combining the findings from the qualitative face-to-face interviews, observations in the field, and member checking.

4.8.2 Transferability

According to Maree (2019:57), transferability exists when we draw general conclusions from the research in relation to the entire population and the setting. This study was embedded in the interpretivist paradigm, which is based on the principle that humans understand their own world through interacting with each other. Transferability was established through data collection instruments such as interviews, documents, observations, and open-ended questionnaires to obtain the results. Therefore, the results presented cannot be transferred to other contexts; hence, the data presented is not stable but changes with the context and also changes from teacher to teacher (Maree, 2019: 61). In this study, transferability was established by concluding the research concerning the study population.

4.8.3 Dependability

Dependability refers to the researcher's ability to convince the readers that the findings of the research have happened as stated and are, therefore, dependable (Cohen, 2013:53). The above-mentioned concept applied to this study because themes and the results of the research were discussed with the participants to ensure that themes and

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the findings are accurate and dependable, using coders, which helped to obtain high inter- and intra- coder reliability. Furthermore, this was done by asking an independent coder to code my data by providing him or her with the objectives of the research and the raw data (Creswell, 2013:61). In this study, dependability was established by discussing the findings of the research with the participants and by asking an independent coder to code the data while providing the research objectives.

4.8.4 Conformability

According to Anney (2018:100), conformability refers to the degree to which the results of an enquiry could be confirmed or corroborated by other researchers. In this study, conformability was ensured by the participants reviewing the final report before it was released so that they could see that what was reported was a true reflection of what they said during the interviews.

4.9 CONCLUSION

The primary purpose of this chapter was to explain how data was collected and analysed. The research paradigm, the research design, and the methodology were also discussed, as well as the population, sample, and sampling procedures. Consequently, data collection strategies such as interviews, observation, and document analysis were discussed. Finally, data analysis and coding were highlighted.

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CHAPTER 5

DATA ANALYSIS AND INTERPRETATION

5.1 INTRODUCTION

The purpose of this chapter was to provide data analysis and interpretation. In this study, data were analysed qualitatively. Qualitative data were collected from the three curriculum advisors responsible for Geography, six Geography teachers, and six Geography learners from Grades 10 to 12 who were selected from three schools in three circuits in Sekhukhune East District. Finally, the data collected was analysed through thematic analysis.

5.2 ANALYSIS AND INTERPRETATION OF CURRICULUM ADVISORS' QUALITATIVE DATA COLLECTED THROUGH INTERVIEWS

This section analyses and interprets all data. Data analysis was divided into the participants' biographical and contextual or empirical information. The biographical data of each category of population was discussed under such.

5.2.1 Biographical Information of the Curriculum Advisors

The biographical data of each category of population was discussed under such.

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Table 5.1: Biographical Information of the Curriculum Advisors

	1.8.1 Biographical Information of the Curriculum Advisors	
Curriculum Advisor No. 1	Age	35
	Gender	Male
	Highest Educational Qualifications	STD
	Post Matric Qualifications	Honours' Degree
	Experience as Curriculum Advisor	5 Years
Curriculum Advisor No. 2		
	Age	40
	Gender	Female
	Highest Educational Qualifications	BAED
	Post Matric Qualifications	P.G.C
	Experience as Curriculum Advisor	4 Years
Curriculum Advisor No. 3		
	Age	55
	Gender	Female
	Highest Educational Qualifications	BEDFET
	Post Matric Qualifications	Masters' Degree
	Experience as Curriculum Advisor	5 Years

The study involved three curriculum advisors of Geography as the participants: two females and one male. Their age ranged from thirty-five to fifty-five years. Their highest educational qualifications ranged from a Bachelor's degree to an Honours degree, whilst their professional qualifications ranged from a Secondary Teacher's Diploma to a Post Graduate Diploma in Education. In terms of experience as curriculum advisors, it ranged from three to six years, whilst their teaching experience ranged from ten to twenty-eight years.

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5.2.2 Contextual Analysis and Interpretation of Data

This section presents empirical analysis and interpretation of data about the curriculum advisors' responses to the interview questions. All responses were converted into themes. All three curriculum advisors in all selected circuits in Sekhukhune East District responded to four interview questions analysed in the following paragraphs.

5.2.2.1 Research Question 1: Which Information and Communication Technology materials do you think could be adopted to enhance the performance in GIS in schools?

The Geography GIS curriculum advisors indicated that the most frequently used ICT materials to enhance GIS in schools are computers and other software, and cell phones are also used. Additionally, the curriculum advisors use laptops provided by the Department of Education to prepare and present their lessons as part of Information and Communication Technology (ICT). The following was said by some of the curriculum advisors when interviewed:

Curriculum advisor 1:

> *"I even use the overhead projectors during meetings with the educators, whereby teachers bring their own laptops to project information."*

Curriculum advisor 2:

> *"All in all, the most frequently used Information and Communication Technology (ICT) in schools is the data and software-driven gadgets."*

Curriculum Advisor 3:

> *"I usually encourage teachers to use orthophotos, topographical maps, satellite images and illustrations such as polygons, and line features, such as rivers, schools and cultivated lands, as examples.*

The literature revealed that the use of Information and Communication Technology in Geography is crucial because it encourages collaboration, critical thinking, and a learner-centred classroom (Ncube, 2018:40). This implies that ICT enables learners to work in

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groups to share ideas and information and to analyse information critically. Additionally, ICT creates a learner-centred classroom where learners are empowered to make decisions, interpret the learning content, and be leaders in the classroom whilst the teacher serves as the facilitator, consultant, and problem solver and is able to scaffold learning activities.

5.2.2.2 Research Question 2: What do you think are the causes of low performance in GIS?

All the curriculum advisors indicated that the most common cause of low performance in Geography GIS is the insufficient knowledge of teachers in GIS, coupled with the incompetence of some teachers in the use of Information and Communication Technology. Hence, GIS requires teachers to use different ICT materials to prepare and present lessons. Additionally, two curriculum advisors pointed out that negative attitudes of teachers towards GIS implementation and teaching are a matter of great concern since the majority of them are reluctant to teach GIS because they lack knowledge, training and relevant qualifications in GIS. The following are some of the extracts of what the curriculum advisors have said**:**

Curriculum Advisor 1:

> *"I think the cause of low performance in Geography GIS is lack of time for teachers on how to use GIS in the classroom as well as the lack of time for the teachers to prepare lessons that are GIS compliant, hence lack of knowledge, negative attitudes of teachers towards GIS, and the lack of knowledge on the use of ICT to present GIS lessons."*

Curriculum Advisor 2:

> *"I think the most important cause of low performance in GIS is the unwillingness of teachers to teach GIS, inadequate knowledge of teachers in GIS, insufficient infrastructure, such as the classrooms designed for GIS lessons, and the lack of GIS laboratories in most schools."*

Curriculum Advisor 3:

> *"Mmm, I think the most common cause of the low performance in GIS is the physical challenges, which include but are not limited to buildings and*

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electricity that function incorrectly are some of the causes of low performance with respect to GIS in most schools."

The literature revealed that the lack of Learner Teacher Support Materials (LTSM) that are GIS compliant in schools is one of the variables that cause low performance (Bayer, 2021:54). The findings from the literature also indicated that the negative attitude of teachers towards Geography GIS is one of the causes of low performance in the subject. Consequently, the same literature indicated that a lack of time for the teachers to teach GIS in the classroom also causes low performance in GIS; the lack of knowledge, training, and qualifications in GIS by the teachers is one of the causes of low performance in the subject (Demicry, 2018:45).

5.2.2.3 Research Question 3: What challenges do you experience in GIS?

The curriculum advisors indicated that most Geography teachers, especially the experienced ones, have negative attitudes towards Geography GIS. Apart from the above, most teachers teaching Geography GIS have no time to plan and prepare lessons on GIS; some are computer illiterate and unable to operate computers and other software, have inadequate knowledge about GIS, and some lack the qualifications to teach GIS effectively. The following are extracts of what the curriculum advisors have said:

Curriculum Advisor 1:

"The most important challenges are that teachers are not trained or educated on GIS, whilst others do not have GIS laboratories in their schools.''

Curriculum Advisor 2:

"The most important challenges are that teachers have inadequate knowledge of GIS points, they have a poor presentation of Geographical features and concepts, and lack textbooks on GIS, which makes it difficult for teachers to understand, and some teachers have improper teaching techniques for GIS."

Curriculum Advisor 3:

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"The most important challenge to teachers is the lack of Learners Teacher Support Materials (LTSM) for GIS. Equally important is that GIS is offered in an overcrowded classroom, which serves as a barrier to GIS technology."

The findings from the literature indicate that teachers experience the challenges of teaching Geography GIS because of their negative attitudes towards GIS (Clavens-Fincham, 2016:4). This implies that if teachers develop negative attitudes towards the subjects they are teaching, learners will also develop the same negative attitudes, resulting in learners' poor performance in GIS.

5.2.2.4 Research Question 4: Which intervention strategies do you think could be explored and adopted to enhance learners' performance in GIS?

The Geography GIS curriculum advisor indicated that fieldwork and the project teaching method are some of the best strategies teachers can explore to teach GIS effectively. Apart from that, teachers can adopt enrichment classes as teaching strategies where learners are given extra lessons as the best strategy. Additionally, the curriculum advisors indicated that the involvement of Geography markers and moderators can improve the learning performance of GIS. Some curriculum advisors said the following when interviewed:

Curriculum Advisor 1:

"The use of fieldwork where learners are exposed to the outside world is one of the strategies where learners can work independently to acquire Geographic knowledge. Consequently, learners may engage in the Geography projects on GIS to gain insight into how to analyse, interpret, and manipulate information on the map."

Curriculum Advisor 2:

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"I think cooperative learning is one of the strategies to teach GIS, and the learner-centred practical work is also suitable for the learners to understand GIS."

Curriculum Advisor 3:

"I think the inclusive teaching strategy where academically challenged learners are accommodated during the teaching-learning process is suitable for the success of learners doing Geography GIS."

The literature review revealed that the project method, the fieldwork method, and group discussion are some of the best and most suitable strategies for the success of GIS lessons (Firormuwe, 2019:1). This implies that when learning is taken outside of the classroom, it is difficult for them to forget what they have learnt outside of the classroom. Fieldwork, like the project, enables learners to think independently, critically, analytically, and construct knowledge without the help of their teachers. During fieldwork, learners learn to encounter GIS-related features such as cultivated land, rivers, and drainage basins, to mention a few.

5.3 ANALYSIS AND INTERPRETATION OF GEOGRAPHY TEACHERS' QUALITATIVE DATA COLLECTED THROUGH INTERVIEWS

This section analyses and interprets data from six teachers teaching Geography in Grades ten to twelve. Data was divided into biographical and contextual information of the participants.

5.3.1 Biographical Information

The participants in this study are six Geography teachers. Three of them are males, and three are females. Their age ranged from thirty-five to fifty-five years. Their highest qualifications ranged from a BED FET to an Honours Degree, whilst their professional qualifications ranged from a Diploma to a Postgraduate Certificate in Education. Their experience in teaching Geography ranged from eight to thirty years.

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Table 5.2: Biographical Information of the Geography Teachers

	Biographical Information of the Geography Teachers	
Geography Teacher No. 1	Age	35
	Gender	Male
	Highest Educational Qualifications	STD
	Post Matric Qualifications	Honours' Degree
	Experience as a Geography Teacher	5 Years
Geography Teacher No. 2		
	Age	40
	Gender	Female
	Highest Educational Qualifications	BAED
	Post Matric Qualifications	P.G.C.E
	Experience as a Geography Teacher	4 Years
Geography Teacher No. 3		
	Age	55
	Gender	Female
	Highest Educational Qualifications	BEDFET
	Post Matric Qualifications	Masters' Degree
	Experience as a Geography Teacher	5 Years
Geography Teacher No. 4		
	Age	36
	Gender	Female
	Highest Educational Qualifications	SPTD
	Post Matric Qualifications	BED
	Experience as a Geography Teacher	15
Geography Teacher No. 5		
	Age	56
	Gender	Male
	Highest Educational Qualifications	BA
	Post Matric Qualifications	Masters' Degree

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	Experience as a Geography Teacher	21 Years
Geography Teacher No. 6		
	Age	42
	Gender	Male
	Highest Matric Qualifications	STD
	Post Matric Qualifications	BEDHONS
	Experience as a Geography Teacher	17 Years

5.3.2 Contextual Analysis and Interpretation

All six Geography educators selected from secondary schools in Sekhukhune East District responded to all four interview questions asked below:

5.3.2.1 Research Question 1: Which Information and Communication Technology materials do you think could be adopted to enhance performance in GIS?

Most of the teachers indicated that they use textbooks, atlases, computers and other software to teach GIS. Two of the six respondents indicated that they used previous Geography question papers to teach GIS effectively. Others said they use gadgets such as smartphones, projectors, Google Earth, satellite images, and paper-based GIS to teach GIS. Some teachers agreed with this view by saying that:

Teacher 1:

> *"I think the use of Google apps and other Information and Communication Technology is suitable for the effective teaching of GIS."*

Teacher 4:

> *"Information from a variety of sources, such as television and textbooks, is some of the materials that we use to teach GIS effectively."*

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The literature revealed that the use of paper-based GIS technology is also effective in teaching GIS. Additionally, the GIS science teaching strategy, which involves the use of remote sensing and software like GIP receivers in the field, is best for GIS teaching (Mkhongi, 2020:28). This GIS technology enhances the educators and the learners' spatial thinking capabilities, thus advancing GIS education. This implies that GIS is a field of study that exposes learners and teachers to fieldwork, thereby improving the teachers' and learners' critical, analytical and handling skills.

5.3.2.2 Research Question 2: What do you think are the causes of low learners' performance in GIS?

Most of the Geography educators indicated that a lack of training and workshops on GIS makes it difficult for the teacher to teach learners about GIS because the teacher has a deficiency in GIS-related knowledge. Two teachers further pointed out that a lack of relevant materials and adequate GIS resources is also one of the causes of low learner performance in GIS. The teachers concurred with the view by saying that:

Teacher 1:

> *"I think a lack of relevant resources, coupled with difficulties in operating technological gadgets, are some major causes of low learner pass rate in GIS".*

Teacher 5:

> *"I think among the causes of low learner pass rate in GIS is the teachers' insufficient knowledge about GIS, the deficiency of the teachers in computers and other software technologies."*

Teacher 2:

> *"I think one of the causes of low performance in GIS is the teachers' deficiency in the subject since the majority of the teaching Geography GIS have no knowledge and background of GIS".*

Teacher 3:

> *"Mmm, most of the teachers are reluctant to teach GIS due to incompetence, have negative attitudes towards GIS, deficiency in*

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computers and other software, as well as lack of time to teach GIS effectively, hence lack of knowledge"

Teacher 4:

"I think lack of training of teachers, lack of qualifications in GIS, and lack of in-service training of the teachers by the government on GIS are some of the variables that cause low performance in GIS."

Teacher 5:

"Yeah, I think inadequate training of teachers in GIS, overcrowding, and lack of GIS laboratories and classrooms are some of the factors influencing low performance in GIS in schools."

Teacher 6:

"I think most of the teachers are unwilling to teach GIS due to, among others,a lack of ICT-related materials that are needed in the subject, as well as the inadequate place for GIS in schools."

The literature pointed out that the causes of low performance of the GIS are attributed to among other teachers' lack of qualification in GIS, the negative attitudes of both learners and educators towards GIS, a lack of Learners Teacher Support Materials for GIS, deficiency of teachers in the operation of computers and other software, a lack of internet connection in schools (Mohammed et al., 2020:46). This implies that Geography GIS serves as challenges to both teachers and learners and for the learners to improve their performance in GIS, the above-mentioned challenges and others should be dealt.

5.3.2.3 Research Question 3: What challenges do you experience in GIS?

All respondents agreed that technology-related challenges, such as a lack of internet connection and a lack of training in technology-related materials and other resources, are the most common challenges that teachers and learners experience. Two respondents further indicated a lack of Learner Teacher Support Materials (LTSM) for GIS, a deficiency in computer skills by teachers and learners, a lack of data, and other software makes it difficult for the teachers to teach GIS effectively. This view is supported by some teachers when they said that:

Teacher 3:

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"I think GIS requires teachers to have access to an internet connection, and as such, I am struggling to impart knowledge to learners in this regard."

Teacher 5:

"I have a challenge of learners having negative attitudes towards GIS and an inadequate supply of Learner Teacher Support Material for GIS."

The literature revealed that Geography teachers encounter challenges such as deficiency in computer skills, a lack of access to the internet, and a lack of Learners, Teacher Support Materials, and other materials that deal with GIS (Mukondeleli, 2018:53). This implies that challenges experienced by Geography teachers are real and must be dealt with to manage Geography GIS efficiently and effectively.

5.3.2.4 Research Question 4: Which intervention strategies do you think could be explored and adopted to enhance the performance in GIS?

The Geography teachers revealed that attending workshops taught by GIS specialists is one of the most suitable strategies for teachers to teach GIS. Consequently, inclusive teaching strategies and cooperative learning strategies could be adopted to teach GIS. Other teachers indicated that the discussion teaching strategy, in which learners are grouped, is best for teaching GIS. The Geography educators concurred with the curriculum advisors by revealing that cooperative and practical work learning strategies are the best for the success of GIS lessons, and they also agreed that projects, fieldwork, discussion, and group work are suitable for teaching Geography GIS. Cooperative learning is the best way to teach learners as they share ideas and best practices.

The Geography teachers revealed that the use of Information and Communication Technology is the most suitable strategy for the success of GIS lessons. Furthermore, previous Geography question papers can be used to teach GIS. Information and Communication Technology Computers, the internet, and other software should be used to teach learners; therefore, theoretical works in teaching GIS are augmented with practical work. The Geography teachers concurred with curriculum advisors by revealing that project learning strategies using both the orthophoto and the topographical maps to

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teach GIS can be effective strategies. GIS textbooks and learner-teacher support materials that comply with GIS could be adopted to teach learners about GIS.

Most Geography teachers indicated that some strategies that can be adopted to enhance learners' pass rate of GIS are attending workshops and being taught by GIS specialists. Besides their workshops, extra classes should be organised where GIS specialists will teach the Geography learners. One of the respondents indicated that some of the best strategies for learners to understand GIS are getting used to weather channels, weather map analysis, satellite image analysis, and becoming inquisitive learners who learn and study beyond their syllabus. This view is supported by the teachers when they say:

Teacher 4:

> *"I think there should be extra classes for the learners and taught by the GIS specialist."*

Teacher 5:

> *"I think as a teacher, the discussion, methods, the project methods and the fieldwork, the involvement of GIS specialists can be adopted to enhance the learner's performance of GIS".*

The literature has shown that the involvement of subject advisors, chief markers, and moderators of Geography may have a positive impact on GIS performance. Enrichment classes, which include Saturday, holidays, and morning and afternoon studies, can effectively improve learners' performance with Geography GIS (Leepo, 2015:70). This implies that teachers should put in extra effort, improve their performance, and give learners extra lessons to improve their performance in GIS.

5.4 AN ANALYSIS AND INTERPRETATION OF LEARNERS' QUALITATIVE DATA COLLECTED THROUGH INTERVIEWS

This section analyses and interprets the data from the learners as respondents. Data was divided into biographical and contextual information of the respondents.

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5.4.1 Biographical Information

The following is the biographical information analysis of the six Geography learners who participated in the study. This qualitative data was obtained from six qualitatively selected Geography learners from Grades 10 to 12. The participants consisted of three female and three male learners. Their ages ranged from sixteen (16) to eighteen years (18).

5.4.2 Biographical Information Table

Table 5.3: Biographical Information of Geography Learners

Biographic Information of Geography Learners		
Learner 1	Age	16
	Gender	Male
	Grade	10
	No years in grade	1
Learner 2	Age	16
	Gender	Female
	Grade	10
	No of years in grade	1
Learner 3	Age	16
	Gender	Male
	Grade	11
	No of years in grade	1
Learner 4	Age	17
	Gender	Male
	Grade	12
	No of years in grade	1
Learner 5	Age	16
	Gender	Female

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	Grade	11
	No of years in grade	1
Learner 6	Age	18
	Gender	Female
	Grade	12
	No of years in grade	2

5.4.3 Contextual Analysis

5.4.3.1 Research Question 1: Which Information and Communication Technology material do you think could be adopted to enhance performance in GIS?

The Geography learners indicated that they used textbooks, software such as Arc GIS, online tutorials, paper maps, and online courses. Two respondents further indicated that they use QGIS, Esri story maps, podcast maps, and cartographic data. The following is an extract of what the learners said:

L2: *"I can use an online tutorial, blogs or books to look for information."*

L3: *" Hmm, "I often use cartographic data in spreadsheets and digital data to learn about GIS".*

L4:

> *"I think computers and other software can be adopted to enhance the performance of learners in GIS, as it is a prerequisite that GIS can only be taught effectively by using computers and other software connections."*

L5:

> *"Hmm,I think internet connection, especially when learning about buffering, data layering, data interpretation, and analysis, can serve to enhance the performance in GIS."*

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The Geography learners indicated that for them to understand GIS and learn about the same GIS data, the internet, computers, and other software are important. The study findings related to Learners' Teacher Support Materials pointed out that GIS requires materials such as computers, maps, software, and competent teachers so that learners can learn GIS with charm and ease (Ncube, 2018:40). This implies that GIS requires Information and Communication Technology as well as computer literature teachers so that learners can understandGeography GIS easily.

5.4.3.2 Research Question 2: What do you think are the causes of low performance in GIS?

Most of the learners indicated that a lack of motivation, a lack of resources and poor learner facilities are some of the causes of low learner performance in GIS. Additionally, two of the respondents pointed out that learners' lack of knowledge and insufficient ability in GIS also contribute to low learner performance in GIS. These are what some of the learners had to say:

L1:

> *"Mmm, limited opportunities for practice and appreciation of GIS skills and limited access to necessary resources and a lack of understanding of spatial concepts are contributory factors to low learners' GIS performance."*

L2:

> *"Yeah, lack of confidence by the learners, lack of practice of GIS by learners, and finally, having a teacher with poor teaching aids makes it difficult for the learners to understand GIS, and this contributes to low learner performance in GIS."*

L3:

> *"I think the teaching methods that the teachers use in GIS lessons are traditional, which promotes memorisation of information, whilst GIS encourages group work, collaboration and problem-solving."*

L4:

> *"Yeah, most schools, including ours, do not have sufficient Learner Teacher Support Materials (LTSM) that are GIS compliant. A lack of GIS*

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laboratories also exacerbates the matter, and most of our teachers seem reluctant to teach GIS. In some instances, this section on GIS is often ignored, but learners are expected to answer some questions based on GIS during mid-year examinations and even final examinations, and these are some of the variables that cause low performance in GIS.

L5:

"I think the low learners' performance in GIS can be attributed to learners' negative attitudes towards the subject as well as the deficiency of learners in interpretation, analytical, and data manipulation skills; hence, GIS requires these skills to be understood."

L6:

"Mmhh, learners who do not have a background in subjects such as Mathematics, Physical Sciences, and Mathematical Literacy perform poorly in GIS because the subjects require learners to interpret, analyse, and manipulate data; so is GIS. That is why the performance in GIS is low."

The literature revealed that the causes of low learner performance in GIS include, but are not limited to, technological challenges such as digital data, GIS software, and a lack of time for instructors to learn GIS. Physical factors such as lack of GIS laboratories and overcrowding in schools also contribute to low learner performance in GIS (Artvinli, 2016:43). This implies that GIS requires both technological and physical resources so that learners can learn and understand easily, and these will improve learners' performance. The absence of the above and other related factors makes it difficult for teachers to teach GIS effectively and for the learners to learn and understand GIS effectively, and if these are not attended to, learners' performance in GIS will be low.

5.4.3.3 Research Question 3: What challenges do you experience in GIS?

Most of the learners indicated that the lack of teaching time by the Geography teachers is a major challenge for them when learning about Geography GIS. Two learners supported this view as follows:

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L2:

"Lack of teaching time by the Geography teachers makes this GIS topic a challenge, yet the same teachers are supposed to teach it."

L3:

"Yeah, as Geography learners, one of our challenges is that Geography GIS teachers have no time to teach this section, and I am unable to understand this GIS. Geography GIS learners further indicated that a lack of resources, a lack of teaching time by the teachers, complex paper-based GIS concepts, and a shortage of information on GIS are the biggest challenges that confront the learners when studying GIS."

The study findings concurred with the literature. The literature made references to many challenges that learners are faced with when learning about GIS, such as the lack of interest, resources, understanding of GIS concepts, and limited access to GIS resources and software (Degirmenci, 2018:191). This implies that learners encounter many challenges in learning and teaching Geography GIS related to Learner Teacher Support Materials.

5.4.3.4 Research Question 4: Which intervention strategies do you think could be explored and adopted to enhance performance in GIS?

Most of the learners indicated that seeking guidance and professional help from other teachers is one of the best learning strategies learners can use to learn GIS, as well as inviting professional GIS teachers to come and teach the learners. Two of the respondents indicated that group discussion and collaboration among the learners during GIS activities are also suitable strategies learners can use to learn GIS effectively. This view is supported by some learners when they had to say that:

L1:

"Learners should give themselves enough time for GIS activities and use collaboration and discussion strategies to understand GIS and look for GIS information through research."

L2:

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"Learners should explore the real world, using online resources as the best and most suitable strategies to learn and understand GIS."

L3:

"I think learning and understanding data analysis, data manipulation, and data interpretation, especially on features appearing on the orthophoto and topographical maps, could enhance the performance in GIS."

The Geography learners indicated that collaboration, discussion, and research on GIS are some of the best and most suitable strategies learners can use to learn GIS. The findings agreed with the literature, which also revealed that delivery of enrichment classes, project-based strategies, and inclusive and differentiation strategies are equally important and best for the learners to learn GIS fruitfully. This implies that appropriate teaching strategies and appropriate learning materials of Geography GIS, such as maps, satellite images, computers, internet connection, GIS laboratories, and other Information and Communication Technology (ITC), are vital for the success of a GIS classroom.

5.5 ANALYSIS AND INTERPRETATION OF GEOGRAPHY TEACHERS' QUALITATIVE DATA COLLECTED THROUGH CLASSROOM OBSERVATION

In this study, data were collected by observing and visiting Geography teachers while teaching learners about Geographic Information Systems in their respective classes.

1. Which strategies do teachers use to teach Geographical Information Systems?

   ……

   ……

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2. What teaching competence do teachers display when teaching GIS?

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3. What are the tools teachers use when teaching GIS?

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……

……

Geography teachers used a variety of learning resources to enhance the performance of learners in the Geographic Information System. It was further observed that the Learner Teacher Support Materials (LTSMS) used in GIS lessons encourage learners to be active participants in the classroom in that learners are divided into different groups and given maps to, among others, identify different features of a geographical nature such as rivers, cultivated lands and any other information of GIS nature.

The researcher made the following observations, among others. During classroom visits and lesson observation, it was discovered that GIS requires teachers to have qualifications that are relevant to GIS because a variety of Information and Communication Technologies are used to teach learners about different aspects of GIS. The use of computers and other software is a prerequisite for the enhancement of learners' performance in GIS. Consequently, it was observed that teaching GIS in schools requires electricity, internet connection, and competency in the use and operation of computers and other software by both teachers and learners for effective implementation, teaching, and learning of GIS. Computer literacy in a GIS lesson cannot be underestimated, and this is the observation the researcher made. For the learners to understand data interpretation, analysis, and manipulation, it was observed that they need to have some skills associated with data interpretation, manipulation, and analysis in order to understand GIS. The researcher also observed that GIS is related to other subjects such as Mathematics, Mathematical Literacy and Physical Sciences in that these subjects deal with data analysis, interpretation and data manipulation.

The researcher further observed that the understanding of GIS requires independent and critical thinking by the learners; hence, most GIS activities, assignments, projects and discussions are done in groups, and individual learners construct meaningful knowledge on their own. The role of the teacher is to facilitate the learning process. Positive

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attitudes by both teachers and learners towards GIS can enhance the learners' performance, and these are some of the observations the researcher made during the observation process in the classroom and during the interview process with the participants.

5.6 ANALYSIS AND INTERPRETATION OF GEOGRAPHY TEACHERS' QUALITATIVE DATA COLLECTED THROUGH DOCUMENT ANALYSIS

Maree (2019:100) shares that documents include, but are not limited to, diagnostic reports, textual books, and mark schedules that are used to gather data during the research process. In the study, the researcher used a mark schedule to collect data about learners' performances in GIS. Additionally, the Diagnostic Report for 2022 and the previous years were adopted to identify the problems learners experienced when answering questions on GIS and the general learners' performance for Geography, in general, and GIS, in particular. Consequently, items and error analysis as used to gather information about challenges learners experience in GIS.

In this study, documents include books, lesson plans, work schedules, and other Information and Technological resources that the teachers use to prepare and present lessons. The Annual Teaching Plans (ATPS) and Programme of Assessment (POA) to teach in GIS effectively also constitute the document analysis.

In GIS lessons, the most frequent resource that the teachers use to prepare and present is the Information and Communication Technology. These include computers and other software. It is through computers and the software that the teachers use to present their lessons on GIS. To some extent, the teachers use cell phones connected to the internet to present lessons, as the learners also use their own gadgets to learn GIS. Teachers also use topographical and orthophotography maps to teach learners GIS. Most of the GIS lessons are presented in the group work format where learners are given orthophotography and topographical maps to interpret, manipulate and analyse data while in their groups, and this encourages independent and critical thinking as well as

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active participation in the construction of knowledge and meaningful learning as groups and individuals.

To supplement Information Communication Technology, teachers use lesson plans that are GIS-compliant to teach their learners effectively. In lesson plans, teachers state the objectives that they want to achieve. For example, by the end of the lesson, learners should be able to manipulate data on both the topographical and orthophotography maps. In addition, all lesson plans are based on the Annual Teaching Plans (ATPS) and the Program of Assessment (POA). In some cases, the teachers use paper-based GIS to present their lessons, as well as GIS software and spatial data maps.

The use of Geography books which assess GIS is the most frequent. Learners Teacher Support Materials to teach GIS. Apart from the books, the teacher uses thematic lessons, overhead projectors and resource packs on GIS. Additionally, computer mapping and analysis materials that deal with GIS are used to supplement GIS lessons.

Finally, GIS workbooks and the development of resource packs on GIS for learners are often used to teach learners about GIS.

5.7 CONCLUSION

In this study, data from the interviews were presented. The interviews were based on the experiences, knowledge and views of Geography Curriculum advisors, Geography teachers and learners doing Geography in Sekhukhune East District in Limpopo Province. The challenges curriculum advisors face, teachers and learners when advising, teaching and studying Geography GIS from the data include the following: the teachers' lack of Information and Communication Technology (ITC) skills, learners' attitudes towards Geography GIS, physical challenges, curriculum challenges, the shortage of Learner Teacher Support Materials, and teachers' attitudes towards GIS and to mention a few.

The next chapter presents a summary, limitations, conclusion, recommendations and suggestions for further study.

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CHAPTER 6

SUMMARY, LIMITATIONS, CONCLUSION, RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER STUDY

6.1 INTRODUCTION

The chapter presents the summary, limitations, conclusion and recommendations for the study. It further gives suggestions for further study and concluding remarks. The study's summary outlines the research questions' findings, a summary of the literature views findings, and the empirical findings. The following questions were directed to teachers, curriculum advisors, and learners:

6.2 HOW THE STUDY RESPONDED TO THE RESEARCH QUESTIONS

This study had three groups of participants: Geography teachers, Geography learners and Geography curriculum advisors, who all responded to the same questions during interviews.

6.2.1 Research Question 1: What is the cause of low learners' performance in Geographical Information Systems?

The Geography teachers revealed that a lack of training and workshops on GIS makes it difficult for teachers to teach learners about GIS because they have a deficiency in GIS-related knowledge. Some teachers add that a lack of relevant and adequate GIS resources also contributes to low learner performance. Furthermore, it was revealed that difficulties in operating technological gadgets also cause low performance in GIS for learners. Consequently, insufficient knowledge of GIS and the deficiency of teachers in computer and software technologies cause low learner performance in GIS. This concurs with the findings from the literature that a lack of technological materials, a lack of data, and difficulties in using GIS software make it difficult for teachers to teach GIS efficiently, and this causes low learner performance in GIS. Considering the participants' responses and the literature, one can conclude that the teachers and the learners experience

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challenges when teaching and studying Geography GIS. As a consequence, learners' performance will nonetheless be low and disturbing in Geography GIS.

6.2. 2 Research Question 2: Which Information and Communication Technology do you think could be adopted to enhance learners' performance in GIS?

The Geography curriculum advisors revealed that schools should be equipped with computers and other software that are functional for effective teaching and learning of GIS. The curriculum advisors further assert that schools, especially those that are located in remote rural areas, should be provided with generators and solar panels so that computer connection becomes simple. Additionally, the same schools should be provided with adequate training on how to operate these technological materials.

The Geography teachers concur that GIS laboratories should be provided to schools so as to make GIS teaching a success. The teachers further argue that the Department of Basic Education provide the computers and other software connected to the internet when delivering other Learner Teacher Support Material when the school closes or reopens. Geography learners posit that Google Maps and other gadgets, including but not limited to cell phones, should be provided to learners who are doing Geography for free to download Geography-related materials. Consequently, all schools should be provided with topographical and orthophotography maps for Geography in general and GIS in particular.

The lireature revealed that Information and Communication Tecnology is the in schools doing Geography is of paramount importance. The availability of different technological materials and Learner Teacher Support Materials that are GIS compliant makes it easy for the learners to improve performance in Geography.

6.2.3 Research Question 3: Which challenges do you experience in GIS?

Geography learners revealed that complex paper-based and GIS concepts have become a challenge for most of us as learners. The lack of resources, poor teaching conditions and inadequate training of teachers on GIS make it difficult for the learners to understand

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GIS fruitfully. Furthermore, the lack of teaching time for Geography educators on GIS is also a challenge. The respondents further concurred with the teacher and the curriculum advisors that the lack of GIS technologies and training of teachers on how to teach GIS is a challenge to teachers, learners, and the curriculum advisors. By looking at the respondents' views and the literature review, we can conclude that GIS is a challenge to learners due to the lack of technological and physical resources of the schools offering Geography.

The literature revealed that technology-related challenges, such as a lack of internet connection and a lack of training on technology-related materials and other resources, are the most common challenges when teaching GIS. Some teachers indicated that the lack of Learner Teacher Support Materials (LTSM) for GIS, a deficiency in computer skills by both teachers and learners and a lack of data and software make it difficult for the teachers to teach GIS effectively. Teachers concurred with the curriculum advisor by revealing that insufficient knowledge, GIS background, and a lack of training on GIS are some of the challenges that GIS implementation faces in schools. Looking at the participants' views and the literature review, one can conclude that teachers, learners, and curriculum advisors face technological, physical, and curriculum-related challenges in the Geography GIS classroom.

6.3 SUMMARY OF THE LITERATURE REVIEW

The summary of the literature review is discussed in this section:
The literature summary showed that geography teachers experience challenges when they teach Geography GIS. The same literature also shows that learners experience challenges when they study Geography GIS. The Geography curriculum advisors, like both the teachers and the learners, experience challenges, which include a deficiency in computer literacy among the Geography teachers, a lack of data and internet connection in schools, and inadequate GIS teaching methods by Geography teachers, to mention a few. The frequent changes in the Geography curriculum affect the teaching and learning of Geography GIS. The form of assessment also affects the learner's performance. The

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literature review also revealed the experiences of teachers in teaching Geography GIS in countries such as Turkey and Nigeria.

Based on the above, it was imperative to come up with acceptable standards of quality for Geography GIS. Some of the acceptable standards are that Geography teachers should establish school clinics and profile learners according to their performance. The study also examined geography-specific challenges with special emphasis on Geographical Information, which includes technological, physical, and curriculum-related challenges of GIS. It was also revealed by literature that learners doing Geography Geographical Information Systems are also struggling with the same GIS content.

The literature further points out the teaching strategies and methods that can be adapted to teach GIS in Geography, which include but are not limited to the use of ITC, discussion, projects, and fieldwork teaching strategies. There are relevant and appropriate methodologies that can be explored to train teachers to help learners in Geography GIS.

6.4 SUMMARY OF THE EMPIRICAL FINDINGS

Qualitative results revealed that Geography curriculum advisors, teachers and learners encounter some challenges when advising, teaching and studying Geography GIS.

The following findings were found:

6.4.1 Challenges Experienced by Geography Curriculum Advisors in Geography GIS

Curriculum advisors experience challenges when advising Geography teachers on GIS matters, such as a lack of background information on GIS, a lack of formal qualifications on GIS, a lack of motivated learners, Teacher Support Materials on GIS, negative attitudes of teachers towards GIS, and so forth. It also transpired that a lack of time to prepare GIS lessons, computer illiteracy, and a lack of GIS laboratories are some of the challenges curriculum advisors encounter when advising teachers in GIS.

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6.4.2 Challenges Experienced by Teachers in Geography GIS

The findings indicated that teachers experience challenges when they teach Geography, in general, and GIS, in particular, such as the lack of computers and software, internet connection, Learner Teacher Support Materials on GIS, and a deficiency in computer skills, to mention a few.

The teachers also pointed out that the class size, which is overcrowded, has an impact on teaching and learning of GIS. The teachers' responses also revealed that these learners' negative attitudes towards GIS, inadequate supply of GIS materials, and a lack of training by the teachers on the use of Information and Communication Technology are also some challenges to the successful implementation of GIS in schools. The teachers' responses also agreed with the findings from the literature that indicated that a lack of learners' GIS skills and Learner Teacher Support Materials that are GIS-compliant also makes it difficult for the teachers to teach Geography GIS effectively. Based on the responses from the participants, one can conclude that teachers, as well as the curriculum advisors, experience challenges when working with Geography GIS.

6.4.3 Challenges that Learners Experience in Geography GIS

Data collected showed that learners experience some challenges when they study Geography GIS. These challenges include, but are not limited to, negative attitudes of geography teachers towards GIS, a lack of learner-teacher support materials on GIS, an inadequate supply of technological and physical resources for GIS, and so forth. The learners' responses concurred with the literature, which indicated that the lack of information and communication technology in schools is a matter of great concern. Based on the participants' responses, one can conclude that learners experience challenges when learning and studying GIS.

In relation to adopted theories, the following findings were found:
The learner-centred methods of teaching and learning should be adopted to the success of GIS in schools because these methods encourage active participation of learners.

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It is through social interaction and peer-to-peer that learners act as active constructors of knowledge rather than being passive recipients of knowledge from the teachers, and it is vital for GIS education. The social interaction where children learn more with knowledge and using their prior knowledge during GIS lessons and doing projects makes it easy for them to take part in the learning process. The use of projects where learners share knowledge and opinions on how to complete the same project encourages social interaction and teamwork. Learners who work collaboratively develop the independent, critical and problem-solving skills and this is possible through social construction of knowledge by the learners on their own, while the teacher serves as the facilitator and scaffolds some of the learners' activities.

6.5 TEACHING STRATEGIES THAT CAN BE ADOPTED TO IMPROVE PERFORMANCE IN GEOGRAPHY GIS

Most of the strategies revealed by some teachers in qualitative findings are teacher-centred. The Geography teachers revealed that using Information and Communication Technology, project-based strategies, fieldwork strategies, discussion strategies, inclusive teaching strategies, and cooperative strategies that are learner-centred strategies can be explored and adapted to teach Geography GIS.

In discussion learning, learners are assessed in groups and compete to see the "best". The inclusive teaching strategy aims to address learning barriers and to assist learners who are academically challenged so as to accommodate all learners with different learning styles and needs. Teachers concurred with the curriculum advisors that cooperative learning is the best way of teaching because the learners share views, ideas, and the best learning practices.

From the qualitative findings, it is evident that all the respondents believe that learner-centred teaching strategies, like discussion, project, fieldwork and cooperative learning, are some of the best and most suitable ways for teaching Geography GIS. Having indicated that curriculum advisors, teachers, and learners agreed that cooperative and other learner-centred strategies are suitable for GIS, it can be concluded that Geography

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teachers should adopt these strategies and use them to improve the teaching and learning of Geography GIS.

6.6 LIMITATIONS OF THE STUDY

This study has the following limitations**:**
The study was only conducted in three circuits in Sekhukhune East District, Limpopo Province. Sekhukhune East is in the rural area of the Fetakgomo-Tubatse Municipality. Possibly, different findings would have been made at the district and provincial levels if the study had been extended to other circuits and districts of the province. Therefore, the findings of the study cannot be generalised to a large area or a provincially based population. The research findings are limited only to the perceptions of the rural area. As a result, the research outcomes could have been different if the schools in urban areas were included in the study.

6.7 CONCLUSION

The study investigated the challenges teachers and learners experience when teaching and studying Geography GIS in selected schools in Sekhukhune East District, Limpopo Province. The literature review and the results from the empirical findings proposed that teachers, learners, and curriculum advisors should receive intensive training on learner-centred teaching and learning strategies to study and teach Geography GIS effectively. Geography teachers should explore and adopt the best and most suitable learner-centred teaching strategies recommended in this study to improve learners' understanding and performance in the Geography GIS curriculum. Therefore, it is necessary to establish a close working relationship between Geography curriculum teachers, Geography curriculum advisors, Geography heads of department, circuit managers and learners for effective learning and teaching of Geography GIS.

The study's contribution to the body of knowledge is geared towards designing and adopting strategies and models that could be adopted to enhance GIS teaching and

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learning. Cooperative and other learner-centred strategies, such as discussion, project, and fieldwork, are suitable to enhance GIS teaching and learning.

6.8 RECOMMENDATIONS

The study recommendations

- The Department of Basic Education and its stakeholders should collaborate with the private sector so that schools can benefit from GIS data and GIS awareness campaigns, so that schools can access data easily.
- Schools should purchase GIS-compliant Learner Teacher Support Materials to provide guidance and explain GIS easily. Those schools with computers can enhance GIS practicality by using free software such as Paper Based GIS, Google Apps, QGIS, and so forth.
- Schools should establish a working relationship with universities so as to improve the quality of teaching and learning GIS, while the DBE serves as a middleman in creating such platforms.
- GIS is computer-based Geography content; the DBE should empower teachers, learners, and curriculum advisors by providing training through workshops and other learning methods and encourage all Geography teachers and affected stakeholders to attend such sessions.
- Schools through the DBE should be encouraged to undertake field trips to industries and companies that deal with GIS daily, so that learners and teachers can learn and understand how to use and operate GIS-related systems, where educators are engaged in practical working with GIS.
- Teachers should help learners analyse, interpret, and manipulate data on topographical maps, orthophotography maps, other photos, satellite images, and so forth.
- As a matter of policy, due to a lack of foundation, it is recommended that learners should be taught basic GIS skills and techniques from lower grades to prepare them for higher grades.

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- For the learners and teachers to change their negative attitudes towards GIS, the curriculum units and stakeholders within the Department of Basic Education must motivate teachers intrinsically and extrinsically as a way of encouraging high performance of learners with respect to GIS.
- The Geography curriculum advisors should also design special programmes of action, workshops, and seminars so as to encourage and motivate teachers towards Geography GIS.
- The DBE should organise in-service training, residential camps, and workshops to train teachers on how to apply learner-centred teaching strategies for the effective teaching of Geography GIS. Further research is needed in formulating a new theory and model as a way of contributing to the body of knowledge.

6.9 SUGGESTIONS FOR FURTHER STUDY

The present study has achieved its purpose, namely, to explore the strategies that could be adopted to enhance learners' performance in GIS and the challenges that teachers and learners experience in learning and teaching Geography GIS in the Further Education and Training Phase. However, there are suggestions for further studies by other researchers:

- The study was confined to three secondary schools in three circuits in Sekhukhune East District. However, not all Secondary Schools and circuits were covered in Sekhukhune East District. Therefore, a further suggestion would be that the same study be conducted in other schools and circuits in order to assess whether the study would produce similar findings regarding challenges experienced by learners and teachers in teaching and learning Geography in schools.

- Longitudinal studies could assist in creating an understanding of long-term patterns in different study areas for exploring other information related to GIS education. For example, conducting a longitudinal study from 2013 to 2023 to assess how GIS was adopted and applied in schools in ten different countries can help.

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APPENDICES

APPENDIX A: CONSENT FORM FOR PARENTS/ GUARDIANS OF LEARNERS

Dear Parent/ Guardian

I am studying for a PhD. Degree at the University of Venda. I am currently conducting research on enhancing learners' performance in the Geographical Information System. Your child is a learner of Geography, whom I identified as one of those who would provide some information on how they are taught GIS.

May I humbly request that you give permission to administer a research data collection instrument on your child?

Yours sincerely

Mabitsela M.S

Name of parent/ Guardian:……

Signature:…… Date:.....

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APPENDIX B: APPLICATION LETTER TO CONDUCT RESEARCH

PO Box 4634
Lydenburg
1120
14 September 2023

The Principals
Limpopo Department of Education
Private Bag x 9472
POLOKWANE
0700

Dear Sir/ Madam

Request to Conduct Research

I, Mabitsela M.S, hereby wish to request for permission to conduct research in Sekhukhune District of the Limpopo Provincial Education Department. Furthermore, I request for permission to conduct interviews with the teachers. The research will form part of the broader GIS project.

Thanks for your attention.

Yours sincerely
M.S Mabitsela



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APPENDIX C: AN APPLICATION LETTER TO CONDUCT RESEARCH

PO BOX 4634
LYDENBURG
1120

The Circuit Managers
Magakala Area Office
Private Bag x 1305
ATOK
0749

Request for permission to conduct research

Dear Sir / Madam

I hereby request for permission to conduct research in your respective schools. The research will form part of the broader GIS.

Thank you for your attention.

Yours sincerely
M. S Mabitsela



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APPENDIX D: CLASSROOM OBSERVATION SCHEDULE

3. Which strategies do teachers use to teach Geographical Information System?

……

……

……

4. What teaching competence do teachers display when teaching GIS?

……

……

……

3. What are the tools teachers use when teaching GIS?

……

……

……

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APPENDIX E: INTERVIEW SCHEDULE FOR THE TEACHERS

Exploring strategies to enhance learners' performance of GIS in Further Education and Training Phase: A case study of Sekhukhune East District, Limpopo Province

1. What are the tools /materials that you use to teach GIS?
2. How have you been trained to use GIS technology?
3. What is the state of performance with respect to GIS at your school?
4. Which strategies can be adopted to enhance the learner's pass rate in GIS in the FET phase?
5. What challenges have you experienced when teaching GIS in the FET phase?
6. What do you think are the causes of low performance in GIS?
7. What is the role of the Geography curriculum advisors in improving learners' performance with respect to GIS?
8. Which are the best teaching strategies teachers can use to teach GIS?

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APPENDIX F: INTERVIEW SCHEDULE FOR CURRICULUM ADVISORS

1. What form of support do you provide to Geography educators about GIS?
2. What ICT material do you use to enhance the pass rate of GIS in schools?
3. How have you been trained in GIS technology?
4. What challenges have you experienced when advising teachers on GIS?
5. What are your roles in improving learners' pass rates with respect to GIS?
6. Which strategies do you think can be explored to teach GIS?
7. What is the role of Geography teachers in improving learners' performance with respect to GIS?
8. What materials do you encourage teachers to use to teach GIS effectively?

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APPENDIX G: INTERVIEW SCHEDULE FOR LEARNERS

ENHANCING LEARNER'S PERFORMANCE IN GEOGRAPHIC INFORMATION SYSTEM: A CASE STUDY OF SELECTED SCHOOLS IN SEKHUKHUNE EAST DISTRICT

1. What materials do you use to learn GIS?
2. What challenges do you experience when learning about GIS?
3. Which strategies do you think are the best to learn and understand GIS?
4. .What do you think are the causes of low learner performance in GIS?
5. What are the roles of teachers in improving learner's performance in GIS?
6. How have you been trained to use GIS technology?
7. What is the state of performance in your school with respect to GIS?
8. What do you think are the best learning strategies learners can use to learn GIS?

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APPENDIX H: EDITOR'S LETTER

Independent Editor
kufazano@gmail.com
+27631434276

SATI
SOUTH AFRICAN TRANSLATORS' INSTITUTE

CERTIFICATE OF EDITING

This confirms that I edited substantively the document below, including a Reference list. The document was returned to the author with various tracked changes to correct errors and clarify meaning.

TITLE: **Enhancing learners' performance in Geographic Information System: A case study of selected schools in Sekhukhune East District**

AUTHOR : **Makgobelele Samson Mabitsela**

Student number: **21011016**

Note: The edited work described here may not be identical to that submitted. The authors, at their sole discretion, have the prerogative to accept, delete, or change amendments made by the editor before submission.

DATE: **25 March 2025**

EDITOR'S COMMENT

The author was advised to effect suggested corrections regarding subject-verb agreement, punctuation and overall academic writing style, to name a few.

Signature

Dr Kufakunesu Zano, PhD in English. A member of the South African Translators' Institute, Ref 1000686, South Africa 2025

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APPENDIX I: ETHICAL CLEARANCE CERTIFICATE UNIVERSITY OF VENDA

ETHICS APPROVAL CERTIFICATE

RESEARCH AND INNOVATION
OFFICE OF THE DIRECTOR

NAME OF RESEARCHER/INVESTIGATOR:
Mr MS Mabitsela

STUDENT NO:
21011016

PROJECT TITLE: **Enhancing learner's performance in Geographic Information System: A case of selected schools in Sekhukhune East District.**

ETHICAL CLEARANCE NO: **FHSSE/24/ECE/02/2308**

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Dr RM Makhwathana	UNIVEN, Early Childhood Development	Supervisor
Prof TS Mashau	UNIVEN, Early Childhood Development	Co-Supervisor
Mr MS Mabitsela	UNIVEN, Early Childhood Development	Investigator-Students

Type: Doctoral Research
Risk: *Minimal risk to humans, animals or environment (Category 2)*
Approval Period: August 2024 – August 2025

The Research Ethics Social Sciences Committee (RESSC) hereby approves your project as indicated above.

General Conditions
While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following.

- The project leader (principal investigator) must report in the prescribed format to the REC:
  - Annually (or as otherwise requested) on the progress of the project, and upon completion of the project.
  - Within 48hrs in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.
  - Annually a number of projects may be randomly selected for an external audit.
- The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the REC. Would there be deviated from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.
- The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date; a new application must be made to the REC and new approval received before or on the expiry date.
- In the interest of ethical responsibility, the REC retains the right to:
  - Request access to any information or data at any time during the course or after completion of the project,
  - To ask further questions; Seek additional information; Require further modification or monitor the conduct of your research or the informed consent process.
  - withdraw or postpone approval if:
  - Any unethical principles or practices of the project are revealed or suspected.
  - It becomes apparent that any relevant information was withheld from the REC or that information has been false or misrepresented.
  - The required annual report and reporting of adverse events was not done timely and accurately,
  - New institutional rules, national legislation or international conventions A it necessary

ISSUED BY:
UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE
Date Considered: August 2024

Name of the RESSC Chairperson of the Committee: Prof M. Mwale-Manjoro

Signature.....

UNIVERSITY OF VENDA
OFFICE OF THE DIRECTOR
RESEARCH AND INNOVATION
2024 -08- 23
Private Bag X5050
Thohoyandou 0950

University of Venda
PRIVATE BAG X5050, THOHOYANDOU, 0950, LIMPOPO PROVINCE, SOUTH AFRICA
TELEPHONE (015) 962 8504/8313 FAX (015) 962 9060
"A quality driven financially sustainable, rural-based Comprehensive University".

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APPENDIX I: ETHICAL CLEARANCE LETTER

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

OFFICE OF THE PREMIER

CONFIDENTIAL

TO: MS. MABOGOMG

FROM: PROFISWARTS

CHAIRPERSON: LIMPOPO PROVINCIAL RESEARCH ETHICS COMMITTEE (LPREC)

REVIEW DATE: 18 SEPTEMBER 2024

SUBJECT: ENHANCING LEARNER'S PERFORMANCE IN GEOGRAPHIC INFORMATION SYSTEM: A CASE STUDY OF SELECTED SCHOOLS IN SEKHUKHUNE EAST DISTRICT

RESEARCHER: MABITSELA MS

Dear Colleague

The above researcher's research proposal served at the Limpopo Provincial Research Ethics Committee (LPREC). The committee is satisfied with the methodological and ethical soundness of the proposed study.

Decision: The proposal is granted full approval.

Regards

Chairperson: Prof I Swarts

Swarts

Secretariat: Ms. J Mokobi

Date: 08/10/2024

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APPENDIX J: ETHICAL CLEARANCE CERTIFICATE LIMPOPO PROVINCE

CONFIDENTIAL

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

OFFICE OF THE PREMIER

Office of the Premier
Research and Development Directorate
Private Bag X9483,Polokwane,0700,SouthAfrica

Tel:(015)2309910,Email:mokobij@premier.limpopo.gov.za

LIMPOPOPROVINCIALRESEARCHETHICS COMMITTEE CLEARANCE CERTIFICATE

Review Date: 18 September 2024 Project Number: LPREC/81/2024:PG

Subject: Enhancing learner's performance in Geographic Information System: A case study of selected schools in Sekhukhune East District

Researcher: Mabitsela MS

ISwarts

Chairperson: Prof ISwarts

Chairperson: Limpopo Provincial Research Ethics Committee

The Limpopo Provincial Research Ethics Committee (LPREC) is registered with National Health Research Council (NHREC) Registration Number **REC-111513-038.**

Note:

i. **This study is categorized as a Low Risk Level in accordance with risk level descriptors as enshrined in LPREC Standard Operating Procedures (SOPs)**
ii. **Should there be any amendment to the approved research proposal; the researcher(s) must re-submit the proposal to the ethics committee for review prior data collection.**
iii. **The researcher(s) must provide annual reporting to the committee as well as the relevant department and also provide the department with the final report/thesis.**
iv. **The researchers will be required to make presentations of the study**

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findings and recommendations at the Provincial Research Conference/Departmental Research Day.

v. **The ethical clearance certificate is valid for 12months. Should the need to extend the period for data collection arise then the researcher should renew the certificate through LPREC secretariat. PLEASE QUOTE THE PROJECT NUMBER IN ALL ENQUIRIES.**

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