GEOGRAPHY TEACHERS' INTEGRATION OF TECHNOLOGY IN THE TEACHING OF MAPWORK CALCULATIONS IN A SECONDARY SCHOOL IN KWAZULU-NATAL

NKANYEZI HILLS CELE

Submitted in accordance with the requirements for the degree of

DOCTOR OF PHILOSOPHY

at the

College of Humanities

School of Education

EDGEWOOD COLLEGE CAMPUS

UNIVERSITY OF KWAZULU-NATAL

20 JULY 2022

DECLARATION

I, Nkanyezi Hills Cele, declare that:

1. The research reported in this thesis, except where otherwise indicated is my original research.
2. This thesis has not been submitted for any degree or examination at any other university.
3. This thesis does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.
4. This thesis does not contain other persons' writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:

   a. Their words have been re-written but the general information attributed to them has been referenced.

   b. Where their exact words have been used, then their writing has been placed in quotation marks and referenced.
5. This thesis does not contain text, graphics or tables copied and pasted from the Internet, unless specifically acknowledged, and the source being detailed in the thesis and in the Reference's sections.

Signed: ………………. [redacted]…………… Date: 20/07/2022

Nkanyezi Hills Cele (Student Registration No.: 201504875

As the supervisor, I approve this thesis for submission.

Supervisor: ………………………………… Date: …………………….

Dr V. Paideya

ACKNOWLEDGEMENTS

I thank Almighty God, the Creator of the Universe, for His guidance, fortitude, and provision of the opportunity to accomplish this vital task in my life.

I wish to extend my sincere thanks to the following people whose support and assistance have made it possible for me to complete this work.

A special word of thanks to:

* My supervisor, Dr V. Paideya, for her invaluable guidance and support, as well as her astute insight and inspiration throughout the study.

* The University's PhD Cohort for their assistance, which has enriched my study to become a valuable contribution I hope, will augment the body of knowledge with regards to the integration of technology in the teaching of geography in secondary schools.

* The editor of my work, Dr L. Lombardozzi, for her assistance in making this thesis the m*agnum opus* it has become.

* My participants who sacrificed their time and supported me in completing this project. You have been superb and I thank you. Continue motivating each other.

* Everyone who contributed and supported me throughout the study in one way or the other, God bless you always.

* A special dedication to my wife, Nokuthula Gaudencia 'Thuli' (MaMkhize) Cele, who has been indispensably inspirational to me throughout my studies. My deepest appreciation for your patience, endless love and support. Our children will carry the torch forward to the next generation in our clan.

.

DEDICATION

This thesis is dedicated to my late parents, Mr Vincent Vusumuzi ‘Mvikseni’ Cele and Mrs Welekazi Janet ‘Nondyebo’ (MaDlamini) Cele. I also dedicate this work to my late grandparents, Reverend Hlabane Hills Cele and Mrs Thembani Ida (MaHlongwane) Cele who were the source of light to this family.

ABSTRACT

The performance of learners in geography mapwork calculations is a major concern for both teachers and Departmental officials in South African secondary schools. Many proposals have and are being made concerning the improvement of learner attainment in geography examinations. However, the problem does not lie in tests and examinations but begins with how mapwork calculations are taught in the classroom. With the change of perceptions regarding teaching and learning in the 21st Century, it becomes necessary to view various options to teaching approaches in the classroom. The proliferation of perceptions about the integration of technology in teaching and learning raises concern about the teachers' praxis in schools and the extent to which they integrate technology in the classroom.

This study explores the integration of technology in the teaching of geography mapwork calculations at a secondary school, juxtaposing the perceptions of teachers in the research site with the perceptions of teachers within schools in the wider district. A concurrent triangulation of data generation methods was employed in the study. Qualitative methods were used to solicit data from participants, namely, qualitative questionnaire, focus group interviews, semi-structured interviews, observations, and document analysis. Two conceptual frameworks, namely TPACK and UTAUT were used to guide the parameters of exploration in the study. The Social Capital theory was used as an analytical framework to provide an interpretation of the findings after data were analysed. This theory was applicable as it allowed people to work together and to access benefits from social relationships.

Although the advent of the COVID-19 pandemic compelled teachers to find alternative ways of continuing their teaching online, despite the adverse conditions that exacerbated their teaching pressures, many geography teachers failed to explore new methods of teaching, using technology. The findings revealed that many teachers were not able to efficiently integrate technology into the teaching of mapwork calculations because of several factors that impacted on the integration in various ways, and many alternative methods employed by geography teachers presented with limitations. School policies, lack of support from internal structures in schools and external structures in the district, and lack of professional development, were found to be limiting factors towards the effective integration of technology to match the demands of the Fourth Industrial Revolution (4IR).

Recommendations were made to ensure that all stakeholders, namely geography teachers in secondary schools, the support structures in schools and the DBE officials, worked cooperatively to improve the performance of geography teachers. Suggestions included the implementation of professional development programmes and the provision of resource infrastructures to assist teachers in their integration of technology in teaching mapwork calculations. However, this research had some methodological limitations pertaining to the sample that was used as a case study. Nonetheless, it provided insight into the way technology integration was carried out in schools and highlighted hindrances towards the efficient implementation of integration programmes. A significant improvement in technology integration was evident at the research site due to support from the school's personnel and technology infrastructure and the effective management of resources within the school. Mentoring of a newly appointed teacher by an experienced teacher was an effective form of professional development on a small scale.

In view of the prevailing conditions at schools regarding technology integration, it is advisable that all stakeholders that partner with the DBE take interest in making schools the centres of powerful knowledge. The contribution from these partnerships will prepare the youth for employment as they complete their schooling career, equipped with knowledge and experiences to meet the demands of the 21st Century. By empowering geography learners with relevant technological skills, on par with the needs of the world of industry, these learners are likely to contribute significantly to the development of science and technology incorporating the geographic expertise that is necessary for future success in the working environment.

The use of the Technology-Enhanced Geography Mentoring Model presented in this thesis will most likely facilitate communication among communities of practice and create a strong bond among the various structures in the bureaucracy. Having identified factors that impact on the integration of technology in Geography through the TePaSig Model, all the structures involved should work towards addressing the factors that prohibit the efficient integration of technology in the teaching of geography mapwork calculations. In so doing, geography learners will develop a solid grounding in mathematical geography and achieve the desired results, as they will be able to work independently using technological devices.

Key words: geography mapwork calculations, technology integration, technological devices, Professional development, 4IR, mentoring, social capital.

ABBREVIATIONS AND ACRONYMS

ACTION: Accessibility, Cost, Teaching and Learning, Integration, Organisation and Novelty

ADDIE: Analyse, Design, Develop, Implement and Evaluate (Model)

ATP: Annual Teaching Plan

BECTA: British Education Communications and Technology Agency

BRICS: Brazil, Russia, India, China, and South Africa

CAPS: Curriculum and Assessment Policy Statements

CBC: Content-based curriculum

CD: Compact Disc

CDE: Centre for Development and Enterprise

CK: Content Knowledge

CT: Classroom Technology

CLS: Course Management System

DBE: Department of Basic Education

DMP: Digital Migration Policy

DST: Department of Science and Technology

DTPS: Department of Telecommunications and Postal Services

DoC: Department of Communications

DVD: Digital Versatile Disc

EE: Effort Expectancy

ESL: English as a Second Language

FET: Further Education and Training

4IR: Fourth Industrial Revolution

GBN: Gauteng Broadband Network

GET: General Education and Training

GIS: Geographical Information System

GPCK: Geographical Pedagogical Content Knowledge

GPS: Global Positioning Satellite

HEIs: Higher Education Institutions

IAI: Interactive Audio Instruction

ICASA: Independent Communications Authority of South Africa

ICT4D: Information and Communication Technology for Development

ICTiE: Information and Communication Technology in Education

IDIA: International Development Informatics Association

IFA: Internet for All

IRI: Interactive Radio Instruction

LoT: Language of Teaching

LTSM: Learning and Teaching Support Material

MDGs: Millennium Development Goals

MoE: Ministry of Education or Margin of Error

Moodle: Modular Object-Oriented Dynamic Learning Environment

NCS: National Curriculum Statement

NCGE: National Council for Geographic Education

NDP: National Development Plan

NEIMS: National Education Infrastructure Management System

NICI: National Information and Communications Infrastructure

OECD: Organization for Economic Co-operation and Development

OBC: Outcomes-based curriculum

PCK: Pedagogical Content Knowledge

PDA: Personal Digital Assistants

PE: Performance Expectancy

PK: Pedagogical Knowledge

PIRLS: Progress in International Reading Literacy Study

PLCs: Professional Learning Communities

PMG: Parliamentary Monitoring Group

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyzes

RMCPS: Revised Modernised Curriculum Policy Statements

RNCS: Revised National Curriculum Statement

RS: Remote Sensing

RSA: Republic of South Africa/ South Africa

SAFE: (Nelson Mandela Foundation's) Sanitation Appropriate for Education

SAICSIT: Southern African Institute for Computer Scientist and Information Technologies

SA-SAMS: South African School Administration and Management Systems

SDGs: Sustainable Development Goals

SECTIONS: Students, Ease-of-use, Cost, Teaching/Learning, Interaction, Organisation, Novelty, Speed

SPT: Social Practice Theory

SS: Social Sciences

TCK: Technological Content Knowledge

TEGMM: Technology-Enhanced Geography Mentoring Model

TEL: Technology-Enhanced Learning

TePaSiG Model: Technological Pedagogical and Support in Geography Model

TK: Technical Knowledge

TIGAS: Trends in International Geography Assessment Studies

TIMSS: Trends in International Mathematics and Science Study

TPACK: Technological Pedagogical Content Knowledge

TPK: Technological Pedagogical Knowledge

UNCF: United Nations Children's Fund

UIS: UNESCO Institute for Statistics

UNESCO: United Nations Education, Scientific and Cultural Organisation

UNESCO-CFT: UNESCO Competency Framework for Teachers

UNESCO-KFIT: UNESCO-Republic of Korea Funds-in-Trust

USA: United States of America

USAO: Universal Services and Access Obligations

UTAUT: Unified Theory Acceptance and Use of Technology

VADEA: Via Afrika Digital Education Academy

WBG: World Bank Group

WCBP: Western Cape Broadband Project

WEF: World Economic Forum

Wi-Fi: Wireless Fidelity

LIST OF TABLES PAGE

LIST OF ANNEXURES & APPENDICES

Table of Contents

CHAPTER 1

SETTING THE SCENE FOR INTEGRATION OF TECHNOLOGY IN TEACHING OF MAPWORK

1.0 Introduction

1.1 Motivation and Overview of the Study

An alarming number of learners who have chosen to study Geography at the Further Education and Training (FET) phase find it difficult to complete tasks pertaining to map work calculations and map interpretation. Many learners fail this aspect in the geography curriculum during the examination (Schoeman, 2018; Innes, 2012; Ahiaku, Mncube & Olaniran, 2019). Earlier research such as the study by Mwenesongole (2003-2005) investigated the factors that contributed to poor and good performances of learners in geography mapwork in the Mafikeng District of the North West province, South Africa (S.A.). The findings of the study established that learners lacked motivation in studying mapwork. The findings further indicated that learners also lacked basic skills to map reading as well as basic mathematical skills in general. The study, therefore, suggested the re-skilling and re-training of geography teachers involved in the teaching of map reading and interpretation, as well as basic mathematical skills. To motivate learners, the study proposed the application of the principles of motivation by geography teachers as suggested by Child (1998) in the teaching of mapwork.

It is not always possible for young learners to perform map work tasks successfully, particularly for those from disadvantaged backgrounds and second language speakers. Many under-performing learners are also children who learn in a language that is not their mother-tongue (Lafon, 2009). Language becomes a prohibiting factor for non-English speakers since they are not familiar with the language that is used on maps, as well as the legend used to orientate them to map interpretation. Learners from non-English backgrounds initially learn mapwork in their mother-tongue and are expected to switch over to English as the medium of instruction as they progress to higher grades. De Guzman, Olaguer & Novera (2017, p.74) assert that teachers who are without the requisite theoretical knowledge and instructional strategies to “develop cognitive academic language proficiency (CALP) skills of English Second Language (ESL) learners fail to develop the discourse patterns that are attendant” to Geography, which constrains the educational achievement of ESL learners. This becomes a barrier to their understanding of mapwork, as they have not developed conceptual understanding of space and place in their mother tongue. A study by Langhan (1993) explains the difficulty that learners from non-English backgrounds experience when working with maps, as these are expressed in a language that is foreign to them. A map, in essence, is one of primary means of communication, much like a language and mathematics, which necessitates the need to be taught and learned through constant engagement.

Apart from the barrier presented by a map legend that is expressed in a foreign language, the coded map may become even more difficult to comprehend for learners who have limited opportunities of visiting places away from their home environment. Moeller & Catalano (2015) make a distinction between ‘foreign’ and ‘second’ language acquisition and use. Foreign language is considered to be the language used only in the classroom and is not spoken in the society where teaching and learning takes place. On the other hand, second language is considered to be the language used by the society where a learner resides. In the South African situation, Geography is taught in English, which is regarded as second language to most of the indigenous learners in schools. Although some learners reside in English-speaking communities, most of them do not. However, English is commonly used in media channels and commercial enterprises which makes it accessible to many. In addition, most of the schools in the country use English as the medium of communication in all subjects, except for the vernacular. Nonetheless, the accessibility of the language does not change its status of being the second language to many learners. This status presents some communication problems in the geography classroom when dealing with specific concepts and geographic processes. The issue of content-obligatory language is key to understanding geographic concepts as it is associated with specific content, vocabulary, grammatical structures, and functional expressions required to communicate subject knowledge (Morawski & Budke, 2017). Learners from English-speaking communities enjoy content-compatible language advantage which allows them to understand the geographic content much better. Content-compatible language is defined as “the non-subject specific language which learners may have in their (German) classes or from everyday language” (Morawski & Budke, 2017, p.67). Undoubtedly, language posits some difficulty in the teaching and learning of geographic content, especially mapwork calculations.

Despite the factors exacerbating the problems of mapwork literacy, the methodological presentation of mapwork literacy in the classroom is always key to mastering mapwork reading and interpretation. Relating a map to the real world does not happen intuitively but is a skill that must be learnt and mastered through regular practice. Geography teachers need to consider alternative ways to teach mapwork skills. The method in which mapwork skills are taught in schools suggests that learners do not acquire and develop the necessary skills that could assist them in their examinations and in their future careers. This has become evident from the poor performance in the examination results of Grade 12 geography learners in the past five years (DBE, 2016–2021).

To change the *status quo* and empower learners so that they can progress in map reading, map-work calculations and interpretation, technology in the form of Information and Communication Technology (ICT) is viewed as an important tool which, if well planned, can enhance learning and achievement (Dambudzo, 2014; Padayachee, 2017). The use of technology is increasingly being incorporated into the teaching and learning process (Sutar, Bhosale & Pujari, 2019; Kafu-Quvane, 2021; Kadhim, 2021). However, Şanlı, Sezer & Pınar (2016, p.235) argue that educational technology "does not contribute much to the improvement of learner performance since student interaction is none or negligible". On the other hand, they propose the integration of technology as it calls for the learners' active participation in teaching and learning using educational technology tools.

1.2 Background of the Study

The conditions under which Geography has traditionally been taught in schools may have been contributing factors to the poor performance of learners in the past five years. This is revealed in the annual Diagnostic Reports of the Department of Basic Education (2016, 2017; 2018; 2019 and 2020). The low level of learner performance at Grade 12 level is an ongoing and persistent challenge (Wilmot, 2016, p.12). Regular annual diagnostic reports are presented each year by the DBE regarding learner performance; however, it begs the question as to why learners continue to perform poorly, particularly in Geography. The persistent reference to the themes of geographical skills and techniques in all FET annual teaching programmes reveal the importance of this aspect in the teaching of Geography. In addition, Larangeira & van der Merwe (2016) argue that this theme is crucial to geography learners as it facilitates the efficient acquisition of map literacy and spatial cognition. They further suggest that spatial cognition, prior learning of map skills and map interpretation at secondary school level are important in advancing map literacy.

The review comments made by the Department of Basic Education (DBE, 2017; 2018 and 2019) reveal a notable lack of knowledge and skills by Grade 12 learners in their responses to middle and higher order questions on Bloom's revised taxonomy during the National Senior Certificate (NSC) Geography examinations. Through document analysis, this was evidenced in the Diagnostic Reports of the DBE, 2017; 2018; 2019; 2020 and 2021) which further determined that learners lacked motivation in doing mapwork calculations. They also showed a general deficiency in map reading skills as well as basic mathematical skills. Maduane (2016, p.61) adds that “non-specialist teachers of Geography would skip mathematically challenging themes in favour of user-friendly sections, at the expense of the future of the vulnerable learners”. Maonga (2015) asserts that a map is a powerful tool in the learning and teaching of Geography, which posits that map skills reinforce graphic skills and develop spatial cognition (Larangeira & van der Merwe, 2016).

In addition, the National Integrated ICT White Paper of 2016 explored the implementation of digital literacy using Information and Communications Technology (ICT) in schools to facilitate improvement in learner performance (DBE, 2016). Meanwhile, the process of providing the digital infrastructure impacted heavily on the country’s budget since both urban and rural schools must be equipped with an efficient network infrastructure to have effective internet access and highly qualified teachers. Nevertheless, the use of ICT by geography teachers in the teaching and learning of Geography is believed to have resulted in multiple economic, educational, and socio-political benefits (N’guessan, 2019; Trucano; 2018; DTPS, 2016; OECD, 2016; 2017; 2018; Friederici et al, 2017; UNESCO, 2018). These studies have shown through econometric tests, that the use and penetration rates of ICTs such as personal computers, mobile phones and the internet, have revealed a positive growth in the economy and in the educational sphere. Investments in ICTs, broadband infrastructure and telecommunications were found to be positively related to growth, especially in the Organization for Economic Co-operation and Development (OECD) countries. The growth levels also indicated multiple benefits for geography teachers, since they require technology in their interaction with their learners and among themselves.

The study explores the integration of technology or Information and Communications Technology (ICT) in mapwork calculations by geography teachers in secondary schools in KwaZulu-Natal. The professional use of technology is explored to determine the extent of the integration. Ramey (2013) describes the professional use of technology as the condition where technology infuses classrooms with digital learning tools such as computers and hand-held devices to expand course offerings, and experiences and learning materials in supporting learning and building 21st Century skills. Furthermore, the use of technology in the classroom is believed to increase student engagement, motivation and accelerate learning. Schools use digital resources in a variety of ways to support teaching and learning by providing electronic grade books, digital portfolios, educational games and real-time feedback on teacher and learner performance, to mention but a few.

1.3 Problem Statement

As mentioned earlier, the ongoing poor performance in mapwork calculations has been attributed to the pedagogical methods of teaching geography mapwork calculations. Several studies conducted in relation to the methods used to teach different aspect of the curriculum reveal that the use of technology in the form of ICTs has improved motivation, learner attention and achievement in the assessment of different subjects in schools (Dambudzo, 2014). However, this does not imply adroitness in the integration of technology in school subjects. Mathevula & Uwizeyimana (2014); Hodgekinson-Williams, Siëborger & Terzoli, (2007); Assan and Thomas, (2012) conclude that the integration of ICTs in the learning environment in schools does not go unchallenged. Various factors impact negatively on the integration of technology in teaching and learning. Nonetheless, the implementation challenges do not completely prevent the integration of ICTs in school subjects, since fair attempts are being made to increase both teachers' and learners' accessibility to various forms of technology that would assist both in their classroom performance.

UNESCO (2015) reveals that the introduction of ICT in education in Southern Africa takes place rather slowly due to several factors which include basic infrastructure, a lack of formal implementation policy, financial resources and teachers with appropriate skills. Carrión-Martínez, et al., (2020) reviewed the scientific evidence on the use of ICTs in education for Sustainable Development following the Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA) guidelines. The results of their research revealed that the most pre-eminent strategies used in the pursuit of technology integration in education are mobile learning and distance education. The ubiquity of mobile phones and the adoption of Course Learning Systems (CLS) made it possible to introduce technology into teaching and learning. Despite the necessity of technological literacy, the teaching process is dominated by traditional methods and the frontal form of work where the teacher has sufficient interactions with students (Stośic, 2015). This practice presents numerous problems in the current conditions where the COVID-19 pandemic has been rampant in schools and throughout the world. The use of educational technology has become more practicable in many countries and in various subjects offered in schools. It is still unclear whether the use of technology in geography teaching has followed suit, considering the failure rate of learners at Matric level. This study therefore aims to promote an in-depth understanding into the effective integration of technology in the pedagogical methods of teaching mapwork calculations.

1.4 Rationale for the Study

Following an extensive exploration of how Geography is taught and assessed in secondary schools, the researcher focussed on how teachers integrate technology into pedagogical methods during the teaching and learning of Geography, especially mapwork calculations. When attending geography cluster meetings, the researcher noted that teachers in fact do discuss the Diagnostic Reports issued by the DBE each year and attempt to resolve the problems that learners encounter during examinations at Grade 12 level. However, despite all the discussions, no visible improvement has been noted, as the results continue to fluctuate unchanged within the boundaries of 50-59% for the past five consecutive years. Most of the problems pertaining to learner performance in geography mapwork are related to mapwork calculations, which is a practical component of the subject.

Despite the challenges that exist in education regarding the teaching and learning of Geography, the integration of technology is a major solution that could and should be used to enhance teaching and learning, by improving the efficiency and productivity both in and out of the classroom (Mdlongwa, 2012). Anyanwu, Govender & Ngwenya (2022, p.172) conclude that the integration of technology extends learning time and facilitates effective and efficient communication. Woolbridge (2004) views technology integration as an instructional tool for delivering subject matter in the curriculum that is already in place, while Ntuli & Kyei-Blankson (2013) refer to it as the utilisation of a variety of digital and hardware tools to ensure the effective application of the teaching and learning process in and outside the classroom. Dockstader (1999) is more specific regarding the type of technology tools, as she defines technology integration as the effective and efficient use of computers to enable students to learn how to apply computer skills in meaningful ways to the general content. Belland (2009) contends that technology is used to help students solve problems. The most common assertion among these definitions is the use of technology software and hardware tools to enhance the teaching and learning process in and out of the classroom. While numerous studies indicate that technology integration only enhances teaching and learning in schools (Clarrion-Martinez et al., 2020; Mensah, Poku & Quashigah, 2021), Padayachee (2017) affirms that the integration of technology is viewed as a panacea towards resolving educational problems in South Africa. Geography has not received widespread attention on the issues of technology integration in its teaching and learning as “there appears to be little evidence that technology is being integrated in classroom activities” (Constance & Musarurwa, p.14, 2018; Ramorola, 2014, p.655).

After perusing an extensive body of literature on the topic from scholarly journals, it became evident that the problem in the teaching and learning of Geography in South African secondary schools (Le Grange and Beets, 2005; Wilmot and Dube, 2016; Ahiaku & Mncube, 2018; Manik & Mahlalela, 2018; Ahiaku, Mncube & Olaniran, 2019; Fleischmann & van der Westhuizen, 2020; Mkhize, 2020) required real and effective changes. These problems appear to have emanated from multiple curriculum changes that have taken place in the country towards the end of the twentieth century. Ongoing poor learner performances in geography mapwork have been noted throughout the first decade of the 21st Century and has remained prevalent as recent as 2020 (Mosoge, Challens & Xaba, 2018; Mkhize, 2020).

The persistent appearance of negative statements in the National Diagnostic Reports for Geography in the NSC examinations about the misinterpretations of questions and miscalculations of geographic phenomena, revealed that the performance of learners had not significantly improved. Similar statements as per below, have repeatedly been made over the past years to date:

- *Candidates experienced challenges interpreting scale. They indicated that the orthophoto map was larger than the topographic map instead of indicating that the scale of the orthophoto map is larger than the scale of the topographic map.*
- *When calculating magnetic declination, a significant number of candidates did not indicate the degrees and minutes in the answer. Others struggled to convert the minutes into full degrees.*
- *Some candidates also experienced challenges regarding the correct use of equipment, e.g. ruler and protractor. This led to incorrect measurements.*
- *Candidates could not identify features on the cross-sections by reading the contour lines on the topographic map.*
- *The concept of ratio scale remains a challenge.*
- *The concept of intervisibility tested was not well answered by most candidates.*

To overcome the problems of poor learner performance in this respect, some suggestions have been made for teachers, included below:

- *Teachers are advised to use past NSC marking guidelines to emphasise the importance of showing degrees and minutes when answering magnetic declination calculations.*
- *Teachers need to ensure that learners can draw and interpret a Cross-section.*
- *Teachers should start with simple illustrations to ensure that learners understand the process.*
- *Teachers should use simple visuals to explain concepts such as intervisibility.*
- *Teachers should have a variety of maps available to them, from past NSC examinations and electronic maps of all NSC examinations given to the provinces by the DBE.*

[Adapted from DBE Diagnostic Reports, 2016 to 2021]

Despite efforts being made to overcome poor performance in mapwork calculations, the problem remains unresolved. The practice of teachers in teaching mapwork raises doubt as to whether they abide by the suggestions made in the DBE Diagnostic Reports.

Furthermore, many international studies reveal appalling conditions in terms of the results in the teaching and learning of Geography mapwork in the Sub-Saharan region (Mndzebele, 2013; Omoro & Nato, 2014; Constance & Musarurwa, 2018; Naxweka & Wilmot, 2019). The international literature reveals similar predicaments in secondary schools in various countries. For example, the study by Veemaa & Jussi (2016) explores the processes, policies and practices for geography and history education in Estonia, which comprised an ethnically divided society from the 1980s similar to that of South Africa under the then Apartheid regime. This was interesting since South Africa comprises a variety of ethnic and racial groups with different cultural backgrounds. Numerous studies have alluded to the debate on the status and authenticity of geography teaching as having ‘powerful knowledge’ (Roberts, 2017; Maude, 2018; Lane, 2018). Other studies reveal more about the conditions related to the assessment of geography education in various regions (Li, Knox & Wright, 2015; Bijsterbosch, 2018; Solemn et al., 2018) in terms of international assessment bodies such as Trends in International Geography Assessment Studies (TIGAS), Trends in International Mathematics and Science Study (TIMSS) and Progress in International Reading Literacy Study (PIRLS).

The conditions experienced in different regions of the world regarding the teaching, learning and assessment of geography education appears to resonate with the conditions experienced in South Africa. Nonetheless, many studies recommend that integration of technology will enhance the teaching, learning and assessment in schools (Hart & Laher, 2015; Khan et al., 2015; Bindu, 2016; Padayachee, 2017; Locsin 2018; Kumaraswamy, 2019; Clarrion-Martinez et al., 2020; Mensah, Poku & Quashigah, 2021). Both the international and local researchers opine that the integration of technology in education augments teaching and learning as well as the performance of learners in assessments (Stośic, 2015; Ige, 2016; Schoeman, 2018; Kafu-Quvane, 2021). Both opinions motivated the researcher to consider exploring the use of technology in the teaching of geography mapwork calculations within the South African context, where most of the learners obtain low marks in the FET phase, hence this study.

The systematic review of literature conducted by Kadhim (2020) indicates that integrating technology in learning and teaching of geography can develop the Geographical Pedagogical Content Knowledge (GPCK) of students, and that students' skills and knowledge in Geography are further expanded using remote sensing (RS) technology as a technology tool used in geography education. In reviewing 5 131 studies, Kadhim found only eight qualitative studies; the rest used either quantitative methods or mixed methods of data collection (See pages 31 and 35 of the research article). The low engagement in qualitative research further motivated the adoption of the qualitative methods of data collection to solicit in-depth and extensive data about the integration of technology in teaching geography mapwork calculations in South African secondary schools.

The integration of technology in the context of teaching Geography at Grade 10 level will be researched. This Grade was selected because it is where Geography begins to assume a more scientific path and more challenging concepts that can present problems to a teacher who has not sufficiently developed map literacy and spatial cognition from an earlier academic career. A study by Ahiaku, Mncube & Olaniran (2019) concluded that the teaching of mapwork is a challenge to sampled teachers, especially the sections on calculations and the Geographic Information Systems (GIS). Their study attributed poor performance to factors such as teacher qualifications, teacher preparedness, inadequate teaching and learning resources as responsible for poor teaching in mapwork. Technology augments advancement and progress in the classroom while teachers who lack basic computer skills and technology integration expertise can bring about the perception of practice being "archaic, ineffective and awkward" (Mensah, Poku & Quashigah, 2021, p.80 citing Earle, 2002). The most recent study conducted in

Akwanga LGA, Nigeria, on the *Challenges Confronting Geography Teachers' Effectiveness in Secondary Schools*, proposed 'training and retraining of teachers on modern techniques of teaching and learning' (Shamle, et al., 2022). This study, therefore, intends to explore the practice of teachers regarding technology integration in their teaching of mapwork calculations in Grade 10.

1.5 Purpose of the Study

The purpose of the study is to understand how geography teachers integrate technology in their teaching of mapwork calculations in their Grade 10 classes. Grade 10 is the first grade that introduces learners to the FET phase of their schooling, where they specialise in particular subjects. Geography becomes insulated from History in this Grade, which before has been part of the Social Sciences learning area from the Intermediate through to the Senior Phase. As Geography and History eventually become separate subjects, Geography becomes more scientific and involves more abstract concepts and complex calculations. Most learners now find it difficult to obtain satisfactory marks in mapwork calculations. The use of technology is viewed as the solution to many problems in education, especially problems that affect teaching and learning in schools. The DBE has been encouraging teachers to integrate technology into their teaching since the beginning of the second decade of the 21st Century. However, learner achievement in Geography remains below the expected level at Matric level. This study, therefore, explores how teachers integrate technology to teach mapwork calculations to Grade 10 classes.

1.6 Objectives of the study

The study aims to provide an in-depth understanding of the practice of geography teachers in terms of integrating technology in their teaching of mapwork calculations at a secondary school in the Umlazi district. The researcher attempts to find answers in relation to the following aims:

- *To explore the types of technologies available for use by geography teachers in the Umlazi District.*
- *To explore the integration of technology to teach geography mapwork calculations in Grade 10 classes.*

• *To explore the implications of integrating technology in the teaching and learning of Geography at a South African secondary school.*

1.7 Critical Research Questions

Responses will be solicited from participants to answer the following critical questions:

• *What are the available technologies that geography teachers use in the Umlazi District?*

• *How do Grade 10 geography teachers in the Umlazi District integrate the available technologies into the teaching of Grade 10 geography mapwork calculations in a secondary school?*

• *Why do Grade 10 geography teachers at this secondary school teach mapwork calculations in the way that they do?*

1.8 Focus and Significance of the Study

The focus of this study is to understand how teachers integrate technology into their teaching of Geography in general, and specific attention will be given to the integration of technology in teaching mapwork calculations to Grade 10 classes. The focus on Grade 10 is significant to establish a trend regarding technology integration up to Grade 12, where performance in geography mapwork calculations is more problematic as indicated by the DBE's Diagnostic Reports (2015 to 2021). It is therefore important to establish the origin of the problem rather than to assess the outcome without knowing the root causes. This study therefore focuses on Grade 10 where the intensive mapwork calculations begin. The study is significant to geography teachers at secondary schools, subject advisors, subject coordinators and the DBE in South Africa and elsewhere in the world. The study will offer insight into how geography teachers integrate technology in teaching the most challenging section in the geography curriculum, namely, mapwork calculations. It will also provide insight into the role of teachers in developing skills in mapwork calculations in secondary schools, including other concerned individuals viz, the Subject Advisors and Professional Development facilitators. The study also hopes to inform the Curriculum Planning and Development sector of the DBE in South Africa in terms of geography teacher development opportunities. The boundaries around mapwork calculations will be extended with a view to integrate technology with the teaching of this aspect, since there appears to be no evidence of technology integration in teaching map work calculations in the Umlazi district, particularly in the Grade 10 classes.

In addition, the theoretical boundaries of the Technology Integration Model will be extended using constructs from the Unified Theory of Acceptance and Use of Technology (UTAUT), the Connectivism theory (CT) and Social Capital theory (SCT). The theoretical extension will assist researchers to create additional connections between the notions of adoption and use of technology, and establish relations between the use of technology and the level of connectivity. This will further introduce the notion of linking various structures that will assist in developing a technology-enhanced teaching of Geography.

1.9 Location of the Study

The study was conducted in a wider geographical area within the Umlazi Education District of KwaZulu-Natal. 120 secondary schools were sampled to participate in the study by responding to a qualitative questionnaire. The Umlazi Education District comprises five circuits, namely, Durban Central, Maphundu, Phumelela, Burlington, and the Umbumbulu Circuit Management Centres (CMCs). Each circuit has four wards under the jurisdiction of a Ward Manager who manages the clusters of schools. The administering of the questionnaire took place across the district and incorporated teachers from schools in various wards.

120 secondary schools were selected from the Umlazi district database.

After scrutinising the questionnaire data, a research site within the parameters of the sampled schools in the district was selected.

1.10 Research Design

This is a qualitative case study design in which qualitative data collection methods were used to respond to the research questions. Qualitative methods of data generation were triangulated to enhance the trustworthiness and credibility of the results. Credibility, transferability, dependability and confirmability as tenets of qualitative research, are explained below.

1.10.1 Research Paradigm

The research is approached from an interpretive paradigm using qualitative methods of data collection, analysis and interpretation. This research follows what scholars contend to be characteristic of qualitative research, namely, that it occurs in natural settings where human behaviour and events occur (Marshall & Rossman, 1980), thereby exploring the processes and meanings of events. This research follows an exploratory case study design where the researcher is the primary instrument in data collection (Eisner, 1991; Lincoln & Guba, 1985: Merriam, 1988), working towards an in-depth understanding of the phenomenon, namely, technology integration into the teaching of geography mapwork calculations, by using multiple sources of data.

1.10.2 Sampling

A questionnaire was distributed amongst Grade 10 teachers across the 120 selected secondary schools in the Umlazi Education district. From the 106 responses received, (fourteen questionnaires were not returned) a selection was made to create three focus groups. The number of focus groups was unlimited, but due to data saturation, only three focus group interview discussions were created. A single school was selected as the research site based on the data from the questionnaires. For ethical reasons, the school was given the pseudonym, Night Owl Secondary School. This is where an in-depth exploration on the use of technology was carried out with teachers from the school. Participants were also given pseudonyms. Two semi-structured interviews were conducted with Grade 10 teachers at the research site. A more extensive description of the research site is provided in Chapter3.

1.10.3 Data Generation Methods

Qualitative data generation methods were used to collect data from participants once the informed consent was obtained. All ethical considerations were followed, starting from the administration of the questionnaire through focus group discussion to semi-structured interviews, observations, and document analysis. Document analysis was conducted at the research site to enhance the credibility of the semi-structured interviews with the participants and observations of teachers in practice.

1.10.4 Data Analysis

Data was analysed using thematic content analysis (TCA). Two conceptual frameworks, UTAUT and TPACK, were used to frame the study within the conceptual constructs to understand the research problem. Data was analysed using text, tables, graphs, and figures to explain the content of all the data collected. The data were interpreted using the theory of social capital as a lens to view the findings from a specific perspective.

1.11 Ethical Clearance

Ethical issues form an integral part of any research project. Bryman (2004) argues that access to the research site is usually mediated by the gatekeepers concerned with the researcher's motivations. Entry into the field was gained after all the formal requirements were fulfilled. In all cases, participants voluntarily engaged in the research study, and were assured that their identity would remain anonymous. More deliberations on ethics are made in Chapter 4.

1.12 Trustworthiness

Qualitative researchers must establish trustworthiness in their research, and this requires a degree of measurement that can bring about a level of authenticity to their studies. This calls for the researcher to persuade the audience regarding the findings in the study, worthy to be considered authentic and valuable. Qualitative researchers do not use instruments with metrics to measure validity and reliability as quantitative researchers do but rely on the trustworthiness of the study. In so doing, it becomes pertinent for qualitative researchers to address the question of credibility, transferability, confirmability and dependability of the findings of their studies. Lincoln & Guba (1985, p.108) argue that the researcher needs to persuade the reader that "the findings are worth paying attention to and that the research is of high quality". These aspects were also investigated to improve the quality of this study by increasing the degree of trustworthiness of the methods used and the findings arrived at.

1.13 Summary of the Thesis

Chapter 1

This chapter seeks to provide the reader with the background of the study by presenting the problem statement, the rationale, the purpose and the focus of this research. This chapter presents the objectives of the study and the research questions that underpin the entire research process. The location of the study and the research design are indicated in this chapter. In addition, a brief summary of the sampling procedures and data generation methods with data analysis are indicated. Ethical issues are described and briefly explained, with further descriptions in Chapter 4. The explanations and descriptions are substantiated with reference to literature that relates to the phenomenon of this research, that is, the integration of technology in teaching mapwork calculations.

Chapter 2

This chapter provides the reader with the reviewed literature on the performance of learners in geography mapwork calculations and the teachers' praxis as reflected in several research studies. The reviewed literature is presented following the chronology from the beginning of the 21st Century to the current dispensation in local and international arenas. The literature explores curriculum and pedagogical issues with respect to geography mapwork teaching and learning in secondary schools. Debates and perspectives are presented with clear arguments on the integration of technology in geography teaching at secondary school level.

Chapter 3

This chapter presents the conceptual frameworks and elaborates on the theoretical underpinnings on which the study is construed. The two theoretical models, namely, Unified Theory of Acceptance and Use of Technology (UTAUT) and Technological, Pedagogical and Content Knowledge (PACK) are analysed with reference to relevant literature. The models are described and the tenets of each model are defined, explained and used to frame the study within the established concepts. The relevance of each theoretical model to qualitative research is explained with reference to literature. In addition, the social capital theory is explained and related to the main thesis of this study. The Social Capital Theory (SCT) was adopted in this study to analyse communication using technology among geography teachers and between teachers and learners. The concepts of the Social Capital Theory, namely bridging, bonding and linking, are compatible for the analysis of technology integration in the teaching of geography mapwork calculations.

Chapter 4

This chapter describes the research problem and the design of the research study. Lacunae in both local and international literature were identified. The methodological approach employed is justified. In view of the research design of the study, triangulation of data collection methods is described in this chapter. Each of the methods used to generate data, namely, qualitative questionnaires, focus groups and semi-structured interviews, observations, and document analysis, is described at length. The theoretical lens used to analyse data is introduced in this chapter.

Chapter 5

This chapter presents data collected from participants and the research site through focus group interviews, semi-structured interviews, observations, and document analysis. Findings are presented textually, in graphs and in tables. Themes that emerge from the collected qualitative data are presented and explained with reference to the relevant literature.

Chapter 6

This chapter actualises the conceptual models (UTAUT and TPACK) in the analysis of qualitative data. Thematic Content Analysis (TCA) is used to develop codes, categories, and themes that emerge from qualitative data collected through focus group and semi-structured interviews, observations, and document analysis. Themes are analysed using the said two conceptual models. From the detailed analysis of data, the two models, Technological Policy and Support in Geography (TePaSiG) and Technology Integration Model (TIM) develop, detailing the processes of technology integration in Geography and the mentoring process of inexperienced teacher respectively. Both models are operationalised in this chapter.

Chapter 7

The summary of the findings is presented in this chapter. Themes that emerged from the qualitative questionnaire are discussed. In addition, themes that emerged from data from the focus group data, semi-structured interviews, observations, and document analysis are discussed. The chapter concludes by discussing factors that affect the integration of technology in the teaching of geography mapwork calculations. A new model, the Technology-Enhanced Geography Mentoring Model (TEGMM), is developed from the constructs of UTAUT, Connectivism and Social Capital.

Chapter 8

This chapter outlines the overall purpose of the thesis by interpreting the teachers' practices in integrating technology in the classroom. The factors that affect the integration are interpreted with reference to the relevant literature. Recommendations to different stakeholders in education at various levels of the bureaucracy are proposed to address the research questions. Finally, further research studies with different designs are proposed to extend the exploration of the phenomena from different theoretical approaches.

1.15 Conclusion

This chapter introduces the study by highlighting the prime components as discussed in Chapters 2 to 8. It summarises the background to the study, outlines the research problem as expressed in the problem statement, the rationale and purpose of the study. The structure of the entire thesis is outlined in this chapter, with reference to the analysed data. The central findings are emphasised as well as the implications and recommendations for future research.

CHAPTER 2

AN OVERVIEW OF LITERATURE ON TECHNOLOGY INTEGRATION IN TEACHING MAPWORK CALCULATIONS

2.1 Orientation to the chapter

The poor performance of learners in Geography examinations at Matric level is a growing concern for geography teachers, subject advisors and the entire education departmental officials who take responsibility to ensure that a significant improvement is achieved. However, learner performance appears to be stagnant or fluctuating below 60% over the past few years. The findings from Wilmot & Dube's (2016) qualitative research study, "Opening a window onto school geography in selected secondary schools in the Eastern Cape Province", reveal that there are systemic and professional factors militating against quality teaching and learning in school geography. The study further reveals that only 53.4% of Grade 12 learners achieved 40% and above. This trend has been consistent in the past five years (DBE 2017-2020; Ahiaku & Mncube, 2018; Mosoge, Challens & Xaba, 2018; Prinsloo & Rodgers, 2018; Naxweka & Wilmot, 2019; Fleischmann & van der Westhuizen, 2020). This is particularly evidenced in the aspect of mapwork, which diminishes the confidence that learners will develop any reasonable spatial cognition that could assist them in mastering mapwork literacy skills and geospatial competence. Ezeudu & Utazi (2014) argue that it is equally important with maps, that spatial relation and spatial forms should best be seen and analysed. Hence, the effective integration of technology is believed to have a positive outcome in the learning and teaching of Geography, as it can develop the Geographical Pedagogical Content Knowledge (GPCK) (Kadhim, 2021; Nkula & Krauss, 2014)). The study further indicates that the use of remote sensing (RS) tools assists in engaging and developing students' knowledge and skills in Geography.

This chapter presents the chronological review of literature concerning the integration of technology in the teaching of geography mapwork calculations in secondary schools, dating from 2000 to date. Literature will be reviewed from the global trends in the use of technology in education and extended to the local trends on the African continent, particularly in South Africa. The integration is linked to the experiences of teachers in secondary schools, which translates into a degree of learner performance. The focus of this research is on the effective teaching of geography mapwork calculations through the use of technology. Early acquisition of map skills and map interpretation at secondary school level are vital in furthering map literacy (Larangeira & van der Merwe, 2016). Map literacy is an essential tool that assists in interpreting complex visual data displayed on maps (Burton & Pitt, 1993), and it is the responsibility of a school to provide the necessary knowledge and skills on the use of maps (Segara, Maryani, Supriatna & Ruhimat, 2018). Despite the importance of mapwork in Geography, Prinsloo, Rodgers & Harvey (2018, p.1) reveal that "South African learner achievement remains poor, despite large investment in schooling over the last two decades". However, the use of technology is believed to improve the performance of learners in the same way that it helps to improve teacher-learner interaction (Valasidou, Sidiropoulos, Hatzis, & Bousiou-Makridou, 2005; Padayachee, 2017; Sutar, Bhosale & Pujari, 2019; Kadhim, 2021). To raise the level of learner performance, teachers need to be empowered and capacitated with the necessary competencies to integrate technology into their teaching. Sutar, Bhosale and Pujari (2019) argue further, stating that ICTs are becoming an indispensable part of the education system, and therefore, their effective integration into teaching and learning is becoming a vital competency for teachers, which is consistent with Wang's (2008) views. This study explores how teachers integrate technology in their teaching of geography mapwork calculations, and why they teach mapwork calculations in the way that they do. A gap exists in the current literature regarding the practice of teachers in integrating technology in teaching geography mapwork calculations to Grade 10 classes within the Umlazi district. This study seeks to close this gap by providing current evidence and perspectives concerning the practices of geography teachers in technology integration in the teaching and assessment of mapwork calculations. The implications of their classroom practice will be explored following the two important research questions mentioned above.

2.2 Definition of Terms

The word 'technology' is a broad term that has been used in education since the 1980s. According to the Thesaurus Dictionary, 'technology' means the application of scientific knowledge for practical purposes, especially in industry. This term is also used to define the equipment, or the machinery developed from the application of scientific knowledge. The term has developed with the introduction of innovations over the years. The development of new knowledge in the field of education, especially in the late 1980s, has led to a change in the term to include more advanced innovations. Pelgrum & Law (2003) indicate that the term 'computers' was replaced by the term 'information technology'(IT), which implied a move away from a simplistic use of computers to the advanced aspects of expanded capacity to store massive information data bases and to retrieve it faster and more effectively. With additional devices and various software packages being developed, coupled with globalisation trends, the term 'Information Technology' assumed a new dimension, to include communication and became 'Information and Communication Technology'(ICT). Bindu (2016) asserts that ICT is a broad and comprehensive expression which ranges from the use of frequency modulation (FM) radio to satellite communication. This is consistent with the description by Sutar, Bhosale & Punjari (2019) that ICT includes radio, television, mobile phones, the computer and the internet. In addition, they point out that traditional ICT such as radio and TV began to include new forms of information transmission when the internet and telecommunications were innovated. According to Habhab-Rave (2011, p.746), the term 'ICT' was promulgated to "reflect the seamless convergence of digital processing and telecommunication. ICTs include hardware, processes, and systems that are used for storing, managing, communicating, and sharing information". This led to new forms of teaching and learning referred to as e-learning.

The Thesaurus Dictionary defines 'e-learning' as learning conducted via electronic media, typically on the internet. E-learning is the application of Information Technology (IT) or Information and Communication Technology (ICT) central to the business of education. ICT is aligned with the digitisation of information whereby information is converted into a computer-readable format, i.e., digital technology. This gave rise to the 'electronic technology that generates, stores and processes data' (Atkinson and McKay, 2007, p.3), followed by new practices in education using educational technology in the late 1990s. Salehi, Shojaee & Sattar (2014) argue that e-learning is effectively made feasible by the presence of ICT. In short, ICT includes all technologies used in the manipulation and communication of information (Desai, 2010). Hence, Locsin (2018) describes the 'ICT network' as the connections used to link electronic devices, for the purpose of sharing information. In this study the term 'technology' will be used generally to include all technologies related to information processing, storing, and retrieving. This is achieved through various forms of communicative devices, software programmes and other tools used by teachers in a teaching and learning situation. ICT is a form of technology that is incorporated under the term 'technology' and no distinction will be made to single out ICTs, but will be treated as technology.

2.3 What is meant by ICT in Education?

Integration of technology in education is the utilisation of technology resources to execute daily activities in the classroom, in school administration and management. Davies & West (2010, cited in Spector et al., 2010) define technology integration as the effective implementation of educational technologies to accomplish intended learning outcomes. Nonetheless, Sadeck (2018) argues that integration advances two distinct possibilities, namely, e-teaching and e-learning. In the process of advancing e-teaching and e-learning, natural activities like communication are facilitated by operating software programmes through hardware devices to access information via cloud computing, internet, or intranet. This is made possible by connecting through wireless fidelity (Wi-Fi), through cables or fibre, sometimes using compact discs (CDs) or digital versatile discs (DVDs), also known as digital video discs. Technology integration is the use of technology tools to teach and learn the subject content in education to allow a learner to apply technology skills in solving problems.

ICT is defined variously in other countries. In the United States of America (USA) and elsewhere, the term was changed from Educational Technology (ET) to Instructional Technology (IT), as it referred to audio-visual education, while in the United Kingdom the concepts of educational technology are referred as Technology-Enhanced Learning (TEL) and is defined as any online facility or system that directly supports learning and teaching (Walker, Voce & Ahmed, 2012). In South Africa, educational technology is referred to as Classroom Technology (CT) or Information and Communication Technology (ICT) and is defined as inclusive of all the resources used for processing, accessing and storing information for communication fulfilment which support electronic learning (e-learning) (Govender and Khoza, 2017).

The two avenues of e-teaching and e-learning function simultaneously in a classroom situation, such that they are inseparable, yet distinctive. Both the natural pathways of teaching and learning include communication, experimenting, experiencing, listening, demonstrating, doing, showing, testing, and so forth. Sadeck (2018) argues that showing and telling are the two most common forms of presenting content knowledge in e-teaching, while e-learning is solely aligned to learning theories, where a teacher plans the use of technology to facilitate learning experiences. In its earlier propositions, UNESCO (2009) pointed out that with the use of advanced teaching methods, ICT can augment the quality of education which will, in turn, improve learning outcomes. Moreover, it suggested that the use of technology will enable educational reform or improve management of education systems in different countries. To emphasise this assertion, the OECD (2021) affirms that ICTs have an increasingly important role to play in virtually all aspects of human daily lives. In support of this statement, Davies & West (2013); Mdlongwa, (2012); Sanders & Schoeman, (2019) state that the use of technology enhances teaching and learning, and that to become productive members of society, both teachers and students need to develop technology skills.

Amid the chaos relating to curriculum reforms in South Africa in the early 2000s, universal trends in the use of Information and Communication Technology in education (ICTiE) were becoming more emphatic. In as early as 2004, the British Educational Communications and Technology Agency (BECTA) report reflected on the pedagogical implications of technologies and the required support to enhance the teaching of Geography. In the report, BECTA listed the key benefits of using ICT in Geography. Among others, the report asserted that the internet increases access to authentic geographical data and information sources (Taylor, 2003 In BECTA, 2004). This emphasises the significance of connectivity to access geographical data when using ICT to deliver the geographic content. To emphasise the assertion made by BECTA, Turpin (2018) claims that South Africa has a well-established ICT infrastructure which extends over a wide area of the country. However, the issue of the digital divide still haunts the DBE in some provinces like KwaZulu-Natal, as revealed in the KZN Digital Transformation Strategy 2020-2025. The digital divide is defined as 'the disparity in access to information and ICT as a result of the differences in terms of class, race, gender, age, and geographic location can effectively deprive citizens of the provincial economy', (KZNDoE, 2020). To address the digital divide predicament, partnerships with various private enterprises have been established, supported by other departments and public sector entities. Besides the digital divide, there have been other factors which have contributed to poor learner performance in geography teaching and learning.

2.4 Factors related to Learner Performance

Low performance of learners has always been an issue for all secondary school learners in a number of subjects, including Geography. A range of factors is mentioned by different researchers about the causes of this educational conundrum. A study by Iwu, Gwija, Benedict & Tengeh (2013) reveals poor learner performance in the Western Cape when investigating the relationship between poor performance and teacher motivation. Various factors that contribute to the conditions are mentioned, however, a correlation between educator motivation and the level of obstacles was noted. A strong need to motivate teachers is emphasised over other antecedents like collegial relationships, conducive working environment and opportunities for advancement. This study informs on what could be the common problems that lead to poor performance in schools elsewhere, although its findings were not intended for generalisation to other settings. A similar study by Fourie & Deacon's (2015) concludes that forming relationships based on trust and receiving feedback is important. The relationship of trust is said to bring about general satisfaction, which results in improved academic performance.

Mosoge, Challens & Xaba's (2018) study relates learners' poor performance to teacher efficacy, concluding that collective teacher efficacy results in improved learner performance. They claim that schools with high efficacy are characterised by strong work ethics and outperform those with a lower sense of collective teacher efficacy. Nonetheless, Prinsloo, Rodgers & Harvey (2018) explored the contributions of specific language factors. They investigated home and school language equivalence, cultural and economic capital, in addition to school and classroom factors. These variables are said to have either a positive or a negative relationship with learner performance. Even earlier studies, such as that of Lundall & Howell (2000) explored variables that relate to academic performances. This study identified class size, parental funding and the length of time computers have been available in the school, as well as the teacher's dedication as contributing factors, or variables to specific performance.

Apart from these important variables mentioned by these scholars, there are other strong variables that contribute to improved learner performances. For instance, findings by Ahiaku, Mncube & Olaniran (2018, p.24) reveal that "educators' teaching and marking experience significantly contribute to educator competence in the assessment, and learners' answering of national examination questions". The marking experience of a teacher leads to the accurate selection of examinable content and questioning skills, since a teacher can conceptualise the structure of the examination paper and how questions are framed at Matric level. Irrespective of the variables identified by various researchers, Naxweka & Wilmot (2019) contend that teachers need to be supported in extending their curriculum and pedagogical content knowledge (PCK) through teacher professional development programmes that are theoretically informed. Principals of schools are the immediate leaders facing a formidable challenge to improve the academic results of their schools. The DBE has attempted to implement a performance agreement with principals, which holds them directly accountable for the performance of their schools (Heystek, 2015). Unfortunately, there is no single explanation or solution for poor learner performance, as the problem persists despite large investments in schools over the past two decades (Prinsloo, Rodgers & Harvey, 2018).

2.4.1 Resources in Education

Resources are a major component that determines school performance on the side of administration and management, as well as teaching and learning. Under-resourced schools result in poor performance in all spheres of school life. Wilmot & Dube (2016) point out systemic and professional factors that militate against quality teaching and learning in school geography. Despite the introduction and implementation of various initiatives since 1994 to address educational inequalities, particularly in disadvantaged communities, such initiatives have not produced the desired results in terms of learner performance (Padayachee, 2017; Sanders & Schoeman, 2019). Moreover, it is geography teachers who are expected to coordinate and fulfil the requirements of the curriculum to achieve the 'terminal behaviour defined as education' (Kocalar & Demirkaya, 2017). However, Munje & Maarman (2017) argue that although the availability of resources in schools influence the learning outcomes, such availability does not necessarily translate into expected outcomes. Resources used in teaching Geography to secondary school learners are expected to involve the use of ICTs as per recommendations by the DBE (DBE, 2016) to transform and meet the increasing demands for digital skills (UNESCO, 2019; WEF, 2020). Nonetheless, Combrincke & Mntatse (2019) conclude that most of the disadvantaged learners have insufficient opportunities and resources available which will have a negative, long-term impact on the country's educational and economic sectors. Since teachers execute teaching and learning programmes, Ezeudu & Utazi (2014) advise that it is important to identify competency gaps among teachers to know what measures are needed to fill those gaps. Identifying the gaps in teacher competencies will assist in the understanding of silent and salient factors that might contribute to hindering the potential of disadvantaged schools to truly assist their learners achieve their educational goals (Munje & Maarman (2017).

2.4.2 The Training of Geography Teachers in the South African Context

The Centre for Development and Enterprise (CDE) 2018 Report reveals that researchers and Government agree that the subject content knowledge and pedagogical knowledge of most

South African teachers are poor, and that this is a major cause for inadequate learner achievement. It further indicates that teachers lack essential knowledge and skills due to inadequate teacher training, which is provided through programmes at higher education institutions in South Africa. The inadequacy of teacher training was extensively discussed in the National Planning Commission (2012) report, which recommended the improvement of teacher performance and accountability to accommodate training, remuneration, incentives, time on task, performance measurement, content and pedagogical support and teacher professionalism. It is believed that the way Geography teachers are trained translates into what they do in their in-service teaching at schools. The disregard of using the latest technology to clarify certain geographical concepts hinders their learners from developing clear spatial cognition and progressive mathematical operations in mapwork. Ahiaku & Mncube (2018) point out that the first step in teaching is to understand what is to be taught and how it should be taught. The possession of ICT skills will enable teachers to impart knowledge embedded in these skills which are necessary to master geography mapwork. It is, therefore, imperative to think spatially when dealing with mapwork, as it implies being able to establish spatial relations on mapwork and translate that into reality. Innes (2012) asserts that it is essential in the geography classroom that geospatial competence is developed with the teaching of map reading, analysis, and interpretation. Such competence cannot be developed within a classroom environment if a teacher has not acquired the competence him-/herself. Hence, adequate teacher training in geographic education, particularly map skills, becomes essential when integrated with ICT in the classroom. Msila (2015, p.1978) adds that "it is difficult to positively bring change in the classroom when there is lack in competence".

According to the 2015 to 2019 Action Plan Report, the DBE has conceded that technology-enhanced learning has not advanced in South Africa (SA) as predicted (Padayachee, 2017). The training of geography teachers in Computer Science (CS) and Information and Communication Technology (ICT) is considered essential in the South African situation. This is consistent with Mannova & Preston's (2017) assertion that CS and ICT are founding parts of a curriculum and every young person should have the opportunity to learn from early years at school. This, however, necessitates teacher training in these aspects as the DBE's focus area is the coordination of the implementation and support of e-education, developing and distributing electronic multimedia resources and ensuring that every teacher in South Africa has access to a laptop (Ngwane & Mbatha, 2017). In terms of the DBE's plan, teacher training and professional development in ICTs, and the provision of ICT infrastructure to every school district will be undertaken by the Provincial Departments of Education.

While other agencies will be ensuring that every school in South Africa has access to the internet and all higher education institutions are able to provide teacher training in ICTs (DBE, 2012; Mdlongwa, 2012; Isaacs, 2007), the use of technology in education is likely to remain a staple throughout the twenty-first century. From as early as 2012, the DBE has been planning to implement the new e-Education Strategy 2013 – 2025, but the programme has not been implemented as anticipated to this day. Through this programme, the DBE aims to provide ICT devices to every learner, and the DBE will support the achievement of educational goals that are sought to improve learner attainment. The introduction of the new e-Education Strategy is consistent with the view held by Male (2016, p.19) that "digital education requires adequately trained teachers capable of delivering content matched to new learning techniques".

Furthermore, the DBE published *The Protocol Document on Teacher Diagnostic Assessments* in 2018 to assist teachers develop in more efficient ways of delivering the curriculum, using the learner workbooks provided, including structuring lessons, covering the material in the curriculum, and conducting assessments (DBE, 2018). The document further aims at assisting teachers to improve their knowledge of the subjects they teach, and are expected to take the initiative in identifying the areas in which they need further development. Teachers are expected to approach the Department for assistance to access training opportunities through the Moodle platform created for both teachers and learners. This is consistent with Koehler and Mishra's (2009, p.67) view that "the successful integration of ICT in the classroom must consider three components, namely, content knowledge (knowledge of subject matter), pedagogical knowledge (knowledge of teaching and learning praxis) and technological knowledge (technical skills)". This study is essential in terms of curriculum development as the intention of the study is to explore how and to what extent the ICT has been professionally integrated into the teaching of geography mapwork calculations by geography teachers in secondary schools, with particular focus on classroom practices.

2.5 Technology in Teaching and Learning

No significant improvement in learner attainment has been experienced over the last decade despite several attempts having been made, with commensurate interventions, to understand the nature and quality of school education (Ramrathan, 2017). Omoro & Nato (2014) propose that teachers must use methods preferred by learners. They argue that this could be localised problems, where teachers fail to identify preferred methods of teaching and learning in the classroom. Even though Segara, Supriatna & Ruhimat (2018) propose the use of models like ACTION and SECTIONS models in the teaching methods, Wang (2008) argues that the effective integration of ICT into teaching and learning is becoming an essential competency for teachers. Ndlovu & Lawrence (2012) emphasise the importance of integrating technology, since the Government has turned to modern technology to strengthen teaching and learning and to redress the past inequalities in public schools. This is consistent with the assertion by Kadir et al., (2014) that ICTs facilitate the acquisition of new skills and promote a positive attitude towards the use of hardware and software tools.

2.5.1 Benefits of Technology Used in Education

Technology is believed to have the potential to improve every country's education system (Mndzebele, 2013). In an early survey by Lundall & Howell in 1998, for the Education Policy Unit of the Witwatersrand University, the researchers concluded that the effective use of ICTs in the process of teaching adds insurmountable value (Howie, Muller & Patterson; 2005). Bindu (2016) argues that the advent of ICT in education assisted to improve the quality of education where teaching and learning eventually became an engaging active process related to real life. Locsin (2018) acquiesces with this view and adds that by integrating any form of technology in education, better learning opportunities are provided for students, thereby improving learning outcomes through modernised classroom practices. Benefits from the use of ICT include increased motivation (Mdlongwa, 2012; Cukurbasi, Isbulan & Chopper, 2016), active participation, improved knowledge and skills, increased responsibility, self-esteem, collaboration (Mdlongwa, 2012; Locsin, 2018), and the development of a sustainable society, provided that their function and structure are deemed to be suitable (Plaza-De la Hoz, 2018). Kadir, et al., (2014) indicate that ICTs influence the development of positive attitude towards the acquisition of new skills, thereby making it possible to improve the quality of life of many people (Carrion-Martinez et al., 2020).

In addition to Bindu's (2016) argument that technology integration enhances accessibility to teaching and learning, Hegarty & Thrompson (2019) appreciate the use of mobile devices. They indicate that technologies promote learning and a more sustainable system of education. On the other hand, Trepule, Tereseviciene & Rutkiene (2014) argue that technology as such cannot improve educational processes, but technology may trigger and enable the use of innovative methods that make learning more efficient and more attractive to learners. They support Shar's (2013) view that the growing use of technology in teaching and learning renders the role of the teacher to be subservient, if not irrelevant, claiming that the teacher has been reduced to the level of an informer and a facilitator. Conversely, the role of the teacher can never be underestimated amidst growing technology. The value of technology integration in education surpasses the perception that views teachers as mere informers. Teachers who integrate technology into their teaching and learning have the upper hand as they benefit in various ways, from easier record-keeping and access to their records, to avoiding loss due to misfiling, lower administrative costs, and less paper wastage, and from easier communication with staff members to curbing examination paper scams (Vodacom, 2015). In teaching and learning, both the teacher and learners benefit in various ways as mentioned hereunder (Stošić, 2015; Harnish et al., (2018):

- Learners are motivated to learn
- Distance learning is made easier
- Learning is more exciting
- Learners are encouraged to learn more independently
- Learners begin to produce knowledge themselves
- Learners realise that they have access to more content via the Internet
- Learners are connected to more experts and have access to global resources
- Learners have access to quality learning material
- Learners show an improved understanding of the topic they are studying

2.5.2 What Value does Technology have in Geography Pedagogy?

Wilmot & Dube's (2016) study identified low performance in Geography in the Eastern Cape in the second decade of the 21st Century and proposed a mutually beneficial partnership in building foundational and pedagogical knowledge of teachers. Their study lays the foundation for practical implementation of technological initiatives in the classroom. The value of technology is without parallel in the teaching of geography mapwork, especially in developing countries like South Africa, where it is viewed as "a panacea towards solving educational challenges" (Padayachee, 2017, p.36). The use of technology in education was further recommended by the Human Science Research Council (HSRC) at the beginning of the 21st Century whereby principals from various schools across countries reported on the "contribution that ICT made to new curriculum approaches, the role of teachers and productive learning activities for students" (HSRC, 2005, p.12). The use of technology was viewed as the solution to many problems that confronted schools and to address the new developments and challenges of the 4IR. However, there is limited knowledge on how technology is being integrated into the teaching of Geography. This study, therefore, offers a new perspective and understanding on how technology is currently integrated in the sampled secondary school in the district which has shown a marked improvement in their Matric results with the use of technology in Geography teaching. In addition, this study is important in establishing the relevance of the ADDIE (analyse, design, develop, implement, and evaluate) model in promoting map literacy skills among geography learners as proposed by Segara, Maryani & Supriana (2018). This study also investigates the collective teacher efficacy that Mosoge & Challens (2018) allude to in their quantitative study on school performance leading to low and high achievements. Furthermore, this study will attempt to evaluate the teachers' spatial conceptual knowledge in mapwork through the integration of technology by using the TPACK models. Naxweka & Wilmot (2019) recommended improving teachers' spatial conceptual knowledge through theoretically informed teacher professional development programmes which will be further investigated in this study. This study explores the phenomenon of technology integration as it emerges from the questionnaire data.

2.6 Policies and Strategies for the Implementation of Technology in Education

Evoh's (2011, p.284) study proposes that African countries need clear policy goals, guidelines and practices in order to realise the full potential of technology in education, while "meeting the challenges of secondary education in the region and to avoid mistakes of the past, ensuring the sustainability of several ICTiE projects". The conscious development of policies regarding the use of technology in education requires a concerted effort on the part of all stakeholders with vested interest in education.

Integration of technology requires formality, and it needs to be based on and informed by policy prescripts. As early as the beginning of the 21st Century, South Africa has been following the universal trends in the provision of quality education. Following a survey by the Education Policy Unit at the University of the Western Cape, it was concluded that the "effective use of ICT adds value to the process of teaching" (Lundall, et al., 2000, p.142). Evidence from this study confirmed the fact that only 32% of secondary schools in the Western Cape used computers to address problem-solving tasks and consequently, those schools were more inclined towards effective teaching. Numerous scholars have held similar views that the use of ICTs in schools would promote effective teaching and learning (Pillay and Hearne, 2010; Davis & West, 2013; Hart & Laher, 2015; Turpin, 2018; Sander & Schoeman, 2019; Fleischmann & van der Westhuizen, 2020; Kadhim 2020). Numerous scholars on the international platforms, who proposed the development of technology policies to facilitate proper implementation of technology programmes, concur with this assertion. The United Nations Scientific Cultural Organisation (UNESCO) developed policy guidelines titled, *ICT Competency Standards for Teachers,* whose objectives were to assist countries to develop their own national education policies with respect to the new socioeconomic trends for the 21st Century. The main objectives of this framework are:

• *to constitute a common set of guidelines that professional development providers can use to identify, develop, or evaluate learning materials or teacher training programs in the use of ICT in teaching and learning.*

• *to provide a basic set of qualifications that allows teachers to integrate ICT into their teaching and learning, to advance student learning, and to improve other professional duties.*

• *to extend teachers' professional development to advance their skills in pedagogy, collaboration, leadership, and innovative school development using ICT.*

• *to harmonize different views and vocabulary regarding the uses of ICT in teacher education.*

[Adapted from UNESCO, 2009:5]

Through this policy framework, a Ministry in each member country was expected to review and assess its current educational policies to incorporate ICT integration in all spheres of the system.

The Ministry of Education in Trinidad and Tobago developed a coherent and sustainable approach to teacher ICT professional development in 2015. This was intended to ensure effective pedagogy and integration of ICT in education, which would encourage learners to embrace technology and become globally competitive knowledge workers (MoE: Trinidad and Tobago, 2015). The Ministry of Education in Dominica developed an almost similar strategy, with the belief that ICT creates new skills within the workforce as a powerful catalyst in transforming education. Many countries such as New Zealand, Turkey, Spain, Nigeria, and others, believe that the use of tablets or mobile devices is beneficial and raises the interest that students have in learning (Kadir et al., (2014). Cukurbasi, Isbulan & Chopper (2016); Plaza-De la Hoz, (2018); Hegarty & Thrompson (2019).

A study by Mothobi, Gilwald & Rademan's (2018) highlights problems encountered in the South African schooling system and proposes a new array of policy developments to enable economic growth through popular digital empowerment of the general citizens. The policy development strategies are extended to the incorporate digital transactions in the education sector. However, Haddad & Alexandra (2002, p.13) earlier warned that "no technology can fix a bad educational philosophy or compensate for bad practice". They propose that education systems first need to make educational choices about the objectives of introducing technology, and methodologies they would be using in the implementation of such technologies, as well as the roles of teachers and students in their policy development. They advised that education policymakers and planners had to be clear about what educational outcomes were being targeted to guide their choice of technologies and the modalities of utilising those technologies.

The DBE's *White Paper on e-Education: Transforming Learning and Teaching through Information and Communication Technologies (ICTs)* (2004) provided the impetus for the strategic implementation of technology programmes in schools and other sectors of society. The implementation was designed to pass through in three phases, namely, to enhance system-wide and institutional readiness to use technologies for learning, teaching, and administration (Phase 1); to facilitate a system-wide integration of technologies into teaching and learning (Phase 2), and practically, technology integrated at all levels of the education system - management, teaching, learning and administration (Phase 3). However, the programme could not assume active and focused implementation due to the disparity between Government expectations and the practice of teachers (Mooketsi & Chigona (2014). The "National Development Plan: Vision 2030" developed in 2012/2013 was, in part, intended to consolidate the proposals of the 2004 White paper.

Furthermore, the *National Integrated ICT White Paper* (2016) which sets the vision of the Government to integrate technology in schools as enshrined in the SA Constitution, and further supported by the National Development Plan to be achieved by 2030, the implementation of technology programmes was set to begin.

Following a briefing between the DBE and the Department of Telecommunications and Postal Services (DTPS) in March 2016, the National Integrated ICT Policy White Paper was developed in September of the same year. The White Paper was aimed at addressing the nine key challenges that are highlighted in the National Development Plan (NDP) by promoting the integration of technology into the school curriculum. These key challenges are premised on several factors, which include the high level of unemployment, poor quality of school education, poorly located technology infrastructure that is inadequate and under-maintained, the digital divide, unsustainable economic resources, inadequate public health system, poor and uneven public services, social inequity, and high levels of corruption (DTPS, 2016). It has been proposed that digital skills are likely to become increasingly essential to employment in many sectors in South Africa soon and basic digital literacy and e-astuteness programmes will assist in alleviating inadequacies and eliminating poverty and illiteracy. It is also foreseen that the application of technology in education will empower the younger generation to overcome challenges that are brought about by the digitisation in the current 4IR. Technologies are diverse and, to a certain extent, intertwined and interrelated as they include radio, television, overhead projectors, smartphones, iPads, landline telephones, internet, interactive whiteboards, mobile phones, computers, and other devices like the Personal Digital Assistants (PDAs). The 2015 *Digital Migration Policy* further necessitated the migration from broadcasting through analogue terrestrial television to a more advanced digital transmission system, 'using satellite transmission for technical capacity to transmit digital signals' (Madikiza, 2011, p.34). This would likely be more compatible with the use of television as a form of technology integration in the classroom.

The introduction of technology in education is in line with the World Bank Group's (WBG) education projects which include support for the use of technologies a certain extent. Programmes such as the SA-School Administration and Management Systems (SA-SAMS) are used in South Africa to capture learners' and school information using digital technology. SA-SAMS is a robust, actively developed and maintained computer application, specifically designed to meet all School Administration, Management and Governance needs of South African Schools (Public, Specialised, Full-Service and Private). However, as of March 2020, only about 12 000 schools out of more than 25 000 schools nationwide use the SA-SAMS programme, of which less than eighty are private schools. The use of ICT in pedagogic interactions in based on the view that ICT has a key role to play in enhancing teaching, learning and assessment practices for teachers and students in primary and post-primary schools (O'Sullivan, 2015).

However, while the strategies and policies exist, Meyer & Gent (2016, p.1) reveal that implementation is slow and capacity is limited. The researchers further claim that there are no clear objectives, and an integrated strategy across the system is lacking while access to technology across provinces and quintiles is limited and unequal.

2.7 Current Technology Integration Programmes

By the end of the 20th Century, Pierson (1999) described technology integration as teachers utilizing content, technological and pedagogical expertise for the benefit of the students' learning. In the Parliamentary Monitoring Group (PMG) meeting held on 17 March 2020, the DBE revealed that in 2019, it had completed its strategy to issue digital Learner Teacher Support Material (LTSM) in the GET and FET bands, with the timeline set for 2019 to 2024.

In line with the e-Education Strategy, the DBE has always been engaged in the process of dispensing educational devices to teachers and learners in public mainstream schools as well as in Special Needs schools. Each province developed a project to issue technology tools to schools in conjunction with network providers that committed to assist with connectivity issues. For example, through its Gauteng Broadband Network (GBN), the Gauteng province manages its internet connectivity and ICT provision programme. The Western Cape followed with the Western Cape Broadband Project, as well as the Limpopo Connect in the Limpopo province. The Eastern Cape provided laptops to Foundation and Intermediate phase teachers in the 2018/2019 financial year through the Universal Services Obligation (USO), aiming to provide the same to senior phase teachers in the financial year 2019/2020 (DBE, 2020). In the Northern Cape, the meeting held on 2 October 2015, revealed that Operation Phakisa managed to provide 92% of schools with one computer for administration purposes, while 28% of schools received computers and other technological devices to enhance teaching and learning and, providing 49% of schools with internet connection. KwaZulu-Natal (KZN), on the other hand, agrees that it has no approved KZN digital transformation strategy that would facilitate the implementation, monitoring and evaluation of the digital transformation in the province

(Office of the Premier, 2020). Digital transformation of all sectors, including education, is vital to enable technology integration in all sectors of society, especially in education, to enhance teaching and learning to meet the increasing demands of technological developments.

However, it is apparent that the provincial departments operate as fragments of the system. This becomes more evident as the pace, level and strategies for delivery are not the same in every province. Meyer & Gent (2016, p.1) confirm this view, asserting that “with no clear, integrated provincial strategies, the progress is fragmented and driven by solution-providers”. The national integrated approach to the integration of technology in teaching and learning is necessary to monitor and assess the progress made by each province. In addition, Guruli et al., (2020) indicate that affordable and sustainable access to technology and internet connection is hampered by a lack of comprehensive and coordinated strategy among various government plans, spheres of government departments, and among private and public actors.

In 2015, the KwaZulu-Natal Provincial Department of Education (KZNDoE) claimed that out of 5 895 schools in KwaZulu-Natal, more than 1500 schools had technology resources and infrastructure, which included the CPU/projector combo, interactive whiteboards, laptop computer, desktop computer, netbook, digital projector, tablet, and so forth, for teaching and learning. In entrenching and fast-tracking the integration of ICT in education, the KZNDoE adopted an *e-Strategy for 2015-2019*, which complemented the National Development Plan, the “Integrated Strategic Planning Framework for Teacher Education and Development in South Africa”, and the “Action Plan 2014: Towards the realization of Schooling 2025”, South Africa Connect and other related policy directives. Despite all these policy initiatives, the programme continues to advance at a slow pace.

Whilst the use of technology in schools is vital, some of the technology tools require connectivity to the internet to access databases and more, from the websites. Thus, the level of connectivity will determine the standard and level of technology usage by a school community. Alternative technological delivery methods of the geography subject content have the potential to succeed, although the effectiveness of these methods has not yet been thoroughly evaluated (Frazier & Boehm, 2012). Nevertheless, to implement the use of technology in education remains the DBE’s initiative and strategy to improve performances in school from all avenues of curriculum delivery. Currently, the ICT in the education roll out programme is underway in most of South Africa’s provinces, following the programme laid down by the DBE in 2017.

Part of the programme (included below) as envisaged by the stakeholders in education to follow in the period 2017/2018 up to the 2021/2022 financial years to ensure the successful roll-out of the comprehensive ICT strategy. Table 2.1 illustrates the annual targets which the DBE together with other stakeholders, was determined to reach by the end of the said period. However, the advent of the COVID-19 pandemic in 2020 necessitated a pause in the roll-out programme and compelled an alternative programme to be put in place. In response to the impact of the pandemic, the school subjects were broadcast on live SOWETO TV and KZNTV, reaching the student population of three million and 2.6 million respectively (DBE Media Statement, 21 April 2020).

Table 2.1: Teacher Professional Development Master Plan 2017-2022, p.28 [Adapted from DBE]

No.	Activity description	Lead agency	Delivery Partners	Key Tasks	Annual targets			
					2018/9	**2019/20**	**2020/1**	**2021/2**
1.1	Establish the National Institute for Curriculum and Professional Development	DBE		1. Set up the NICPD in the DBE.	Concept document developed on the further expansion of the NICPD	Approval of the expansion concept note and development of an expansion plan	Implementation of expansion plan within approved funding	Implementation of expansion plan within approved funding
				Appoint staff in the NICPD	Full staff complement to be appointed	Appointment of full staff complement.	Appointment of staff as per the expansion plan	Appointment of staff as per the expansion plan
				3. Provide resources for the NICPD to execute its work of coordinating deployment of teacher diagnostic self-assessments and quality short courses	NICPD to be fully funded to carry out its mandate	NICPD to be fully funded to carry out its mandate	NICPD to be fully funded to carry out its mandate	NICPD to be fully funded to carry out its mandate
1.4	Develop and deploy a TED ICT support system	DBE: NICPD and CI; SACE; PEDs; Mindset; NEC	PEDs; DBE Partners; Service providers	1. Creation of platforms and apps; strengthening teacher capacity and digital learning	Digital learning resources are integrated with teacher development activities supporting the NCS	1. Initiate the development of a mobile microlearning platform;	1. Mobile microlearning platform (MMLP) commissioned; 2. Evaluate MMLP 3. Integrate with broader TD platform	1. Evaluate mobile micro-learning platform
				2. developing an online searchable database of courses and micro learning resources; deployment of broadcast programmes; designing and deploying a mobile microlearning platform	1. Implement online digital learning self-reflection tool integrated with database of aligned digital learning courses; 2. Liaise with SACE and approved providers for integration of database for SACE endorsed activities	1. Develop microlearning TPD resources to support digital learning as pilot for broader application to TPD; 2. Integration with SACE database of endorsed activities.	1. Develop microlearning TPD resources for digital learning to support curriculum focused digital learning competencies; 2. Digital learning resources are integrated with teacher dev. activities supporting the NCS	1. Develop microlearning TPD resources to support curriculum focused digital learning competencies; 2. Digital learning resources are integrated with teacher dev. activities supporting the NCS
				3. Operation Phakisa: teacher PD in digital skills & competencies	Work with partners in the implementation of the Framework	Work with partners in the implementation of the framework 2. Develop digital learning support resources	Work with partners in the implementing Framework; 2. Develop micro-learning TPD resources supporting digital learning pedagogies	Collaboration in implementing digital learning; 2. Develop micro-learning TPD resources supporting digital pedagogies

The main connectivity initiatives in schools as driven by the Department of Telecommunications and Postal Services (DTPS) and Operation Phakisa from 2014 to 2017 showed a steady progress. However, from 2018 to 2020, the connectivity initiatives terminated in contrast with the envisaged technology integration White Paper initiatives (DTPS, 2016). It is only in 2021 that the KZNDoE resumed a steady supply of 100 tablets to four schools under the Amajuba District, with MTN providing a 3G router for each school to connect thirty-two users at a time. However, connectivity appears to be short-lived as the MEC for KZNDoE, promised to provide each school with a 20GB Data for six months (KZN Media Alert, 12 May 2020).

In implementing the technology in education programmes, the Universal Service Access and Obligations (USAO) - Obligations for all four licensees (Vodacom, MTN, Telkom and Cell C) sought to distribute ICT equipment to Mainstream and Special Needs schools as follows:

Table 2.2: The supply of Technology equipment packages for Mainstream and Special Needs Schools

Mainstream Schools		Special Needs Schools
2x Tablet/Laptop Trolleys 1x Server (for use for proxy service, mail services, web caching and software distribution) 1x PC or Laptop, and a multifunction laser printer (for administration of teaching and learning) 26 x Laptops or Tablets (24 for learners and 2 for teachers) 1x Multifunctional Laser Printer for learners 1x Data projector and Interactive whiteboard (optional) 2x Wi-Fi Access points		2 x Laptop Trolleys 1 x Server 2 x Wi-Fi Access Points (LTE Routers) 4 x Teacher Laptops 30 x Learner Laptops 1 x Printer 2 x Multimedia Projectors Internet Connectivity Schools will receive devices and software in accordance with the schools' disabilities, level of disabilities and needs as per assessment by the Technology and therapist teams
With connectivity, the licensee would provide technology devices for teaching and learning at Mainstream schools		Special Needs schools would receive devices and software in accordance with the schools' disabilities, level of disabilities and needs as per assessment by the Technology and therapist teams.

The resources the DBE sought to supply to schools as Tabled in 2.2 above have not been fully supplied to the institutions as planned, and inadequate progress has been made to furnish schools with the promised equipment (Pillay & Hearn, 2010; PMG, 2016; van As, 2018). The packages were envisioned to assist learners both in the Mainstream schools and Special Needs

Schools (SNS). However, Ankiewicz (2021) reveals that in a developing context, with insufficient logistical resources and where teachers are inadequately trained, development is perceived to be regressing to a specified and fixed content-based curriculum (CBC) rather than to the open and flexible outcomes-based curriculum (OBC).

Teachers' centres are not an exception when implementing ICT in education programmes because they provide convenient spaces and adequate supplies of resources that could be used to train teachers during professional development programmes. However, the recent study on the use of six teachers' centres to support teachers' learning revealed that teachers seldom use the available resources and only use the centres for workshops and meetings (Ajibade & Bertram, 2020). Even though these centres have the space, computers, and science laboratories, as well as libraries, which provide the ideal opportunity for teachers' professional learning, the researchers conclude that these centres are not supporting the full vision of the policy to enhance teacher development.

The number of teachers who have been trained in the use of technology in the KZN province shows a significant gap among those who received basic training, intermediate training, and advanced training. Table 2.3 below shows the number of teachers in KwaZulu-Natal schools from primary to secondary schools. Considering the number of teachers in the province, which amounts to 92 232 (21.6% of teachers in the entire country), a very low percentage had received training as shown in Table 2.4 below. The data showed that only 22.54% of teachers had received some form of training, with only 2 275 teachers having received advanced training in 2020. Only a few of the entire teacher population had received basic training (8 725) and intermediate training (10 343). These statistical data bear testimony to the inadequacy of the training of teachers to integrate technology into their teaching in the province.

Table 2.3: Statistical data of teachers in the KZN province in 2022

Total number of teachers in public schools	Total number of teachers in independent schools	Total number of teachers in the country	Total number of teachers in the KwaZulu-Natal province	Percentage of teachers in KZN as of national teachers in total	Number of public and independent schools in KZN, respectively
92 232	**4 427**	**447 123**	**96 659**	**21.6**	**5 821; 215**
[Adapted from School Realities, published in January 2022]					

In pursuing the programme aimed at training teachers in the use of technology in teaching, the DBE through its Portfolio Committee, presented a report on 17 March 2020 on the progress made as illustrated in Table 2.4 below.

Most of the teachers in KwaZulu-Natal had only received basic and intermediate training skills in using technology in their teaching.

Table 2.4: The number of teachers trained in the use of ICT and their level of training

NUMBER OF TEACHERS TRAINED IN ICT AND THEIR LEVEL OF TRAINING

Province	2015/2016				2017/2018				2019/2020				
	BASIC	INTERMEDIATE	ADVANCE	TOTAL	BASIC	INTERMEDIATE	ADVANCE	TOTAL	Basic	Intermediate	Advanced	TOTAL	GRANT TOTAL
Eastern Cape	2999	782	632	4413	8826	14653	2852	26331	4056	2667	291	7014	37 758
Free State	408	8092	632	9132	8172	3593	6378	18143	181	185	39	405	27 680
Gauteng	1171	502	632	2305	4028	6885	1326	12239	1987	1700	600	4287	18 831
Kwazulu Natal	57	1555	632	2244	4186	8315	1507	14008	4470	351	295	5116	21 368
Limpopo	700	300	632	1632	2632	4564	8828	16024	343	223	20	566	18 222
Mpumalanga	3416	12914	632	16962	5599	6778	1226	13603	1236	592	321	913	31 478
North West	2638	1307	632	4577	8615	14592	2787	25994	296	4675	266	5237	35 808
Northern Cape	374	1187	632	2193	4131	7888	1458	13477	301	121	266	688	16 358
Western Cape	38 314	250	632	39 196	7760	7206	23 416	38 382	6973	3221	3245	13 439	91 117
Total	50 077	26 889	632	77 598	53 949	74 474	49778	178201	19843	13735	5323	37 665	298 620

NATIONAL DEVELOPMENT PLAN 2030 36 Read to Lead A Reading Nation is a Leading Nation

[Adapted from the DBE Portfolio Committee Report presented to South African Parliament]

2.8 Contextual Challenges in Geography Education in South Africa

After a decade into democracy, South Africa celebrated many changes implemented to address the issues of social transformation and equity. Among the changes made, was the introduction of the national curriculum frameworks for General Education and Training (GET) and Further Education and Training (FET). Le Grange & Beets (2005), point out that the new curriculum structures appeared to be somewhat precarious in relation to the status of geography teaching and learning in schools. The reviews of the national curriculum since 1994 led to the introduction of Outcomes-Based Education (OBE) in 1997, the Revised National Curriculum Statement (RNCS) in 2002, the National Curriculum Statement (NCS), Curriculum 2005, and eventually the Curriculum and Assessment Policy Statements (CAPS) in 2011 (Jansen, 1996; Chisholm, 2004; Smith & Arendse, 2016). These curriculum reforms, however, were short-lived and could not produce the desired outcomes due to "in-built mechanisms within the education system that limit opportunities for the majority of learners from working class families", (Mubanga, 2012, p.6), most of these which were systemic in nature.

Recent studies point to the fact that the use of technologies results in improvement in academic performance (Priva, 2019; Moussa, 2019; Trucano, 2018). Dambuzo (2014) opines that the use of technology motivates learners and enhances their attainment and achievement. The provision of technology infrastructure, teacher training and the use of technology in South African schools is facilitated and monitored by The World Bank Group (WBG) as the largest financier of education in developing countries. The WBG is committed to assisting these countries to reach Sustainable Development Goals (SDGs) that call for access to quality education and life-long learning opportunities for all by the year 2030. The World Bank Group supports technology use in education through financing, policy advice, technical support and research. It encourages the training of teachers in the use of technology as it reiterates in its principles that technology should support teachers and not replace them. However, a quantitative study involving 146 participants was conducted in the Limpopo Province to investigate the impact of technology equipment availability and accessibility, and teachers' training in technology use in the curriculum related activities. The findings reveal that, except for the TVs, photocopiers and laptop/desktop computers, there is a scarcity of technology resources available at schools for technology integration. It further revealed that the teaching and curriculum administration functions of most teachers have been negatively impacted on by a lack of technology equipment and/or insufficient use of these technology resources for those schools who have them (Mathevhula & Uwizeyimana, 2014). The teaching of Geography is no exception in this predicament. Moreover, while some teachers had received some form of training in technology, it was evident that such training had minimal or no impact at all on the abilities and confidence of teachers to use technology in their teaching. This is particularly evident in mapwork teaching for Geography.

Mapwork competencies facilitate the understanding of Global Positioning Satellite (GPS) and GIS-based systems which are the modern navigational technologies that appear in everyday life (Wigglesworth, 2003). This implies that teachers of Geography are bound to integrate technologies in their teaching of mapwork to facilitate learners' understanding and to improve literacy which will eventually develop their geospatial cognition. Some software applications are recommended by the DBE for use by geography teachers in different grades (DBE, 2018). These applications are intended to assist teachers to teach different topics in their Annual Teaching Programmes (ATPs). The use of computer applications and other technological devices and tools are believed to raise the status of geography teaching in secondary schools. Al Murshidi & Wright, (2022, p.232) further argue that "one aspect which has transformed teaching is information and communications technology". However, they indicate that professional development has been slower in embracing the digital era.

Education is said to be a highly socially oriented activity while its quality has been closely related to the strength of teachers having personal contact with learners on a daily basis. Kumaraswamy (2018) asserts that the use of ICT in education initiatives has brought about new learner-centred settings which is expected to increase and become more important in the 21st Century schooling. However, Hart & Laher (2015) warn that having access to educational technology and competence to make use of it do not guarantee a successful integration in the classroom.

Traditional learning theories in the curriculum teach learners to be critical thinkers but often lack action-oriented training to prepare them for future careers in geography education (Wang, et al., 2020). This is particularly applicable to developing countries. For example, most African schools are faced with high subscription and technology infrastructure costs coupled with the poor quality of service providers, and the lack of basic infrastructure such as electricity that act as barriers to the use of technology in education (Mndzebele, 2013). This also holds true for the South African curriculum where the integration of technology in geography teaching, amongst other subjects offered in secondary schools, is not emphasised due to some of these problems. The need to reconfigure the schooling system to meet the demands of our changing world in the 21st Century has become ubiquitous in all sectors, be it academic or industrial, private or public. Mishra, Koehler & Henriksen (2010) argue that there have been efforts to ensure that higher order cognitive processes such as creative problem-solving and critical thinking are emphasised in the education process. This is evident in what the DBE (2003) envisages in the "National Curriculum Statement Grades 10 – 12", which aims to develop a high level of knowledge and skills in learners. There have always been calls for a new kind of learning in which learners deal with knowledge in an active and self-directed way using computers and the internet. It has been noted that earlier technologies such as television play a significant role in education, especially in the least developed countries. However, the implementation of technology integration has always been a problem in South African public schools, which limits the acquisition of technological skills by geography learners. Mndzebele (2013) asserts that the lack of knowledge regarding the use of technology and a lack of skills in technology tools and software have also limited the use of technology tools in teaching and learning. Ihmeideh (2009) and Tapan (2009) concluded that if there were a lack of appropriate staff training and quality training for teachers, the results would be dismal, which is still relevant in 2022. A similar conclusion was adopted by Shamle, et al., (2022) that the provision of support for training and retraining of in-service teachers assist in updating their knowledge on new teaching methods and materials that would ensure the identification of effectiveness in improving teachers' performance in their area of study. A similar condition is believed to be prevalent in South African secondary schools, considering the poor performance of geography learners at Matric level in the past five years.

It cannot be contended that digital education requires adequately trained teachers capable of delivering content matched to new learning techniques. Duncan (2016) indicates that digital education is a national priority in South Africa, as the country is moving toward a 'paperless' classroom. Hence, there is no doubt that teachers need to be acquainted with new teaching strategies that involve the use of technologies to teach the subject content. In addition, it is evident that there is an uneven distribution of teachers with adequate skills to teach, and who are equipped to deliver a comprehensive digital programme. According to the DBE, in 2016, only 26% of teachers possessed basic technology skills and only 7% had intermediate skills in the use of technologies for teaching and learning; most of them are based in Gauteng and the Western Cape. The other seven provinces where rural schools dominate the provincial education, have a myriad of problems in relation to digital education. Nonetheless, KwaZulu-Natal presented the strategic priority areas for the provincial digital transformation in 2020 and identified six priorities which include connectivity, digital upskilling, information management and security, process automation, systems integration, and digitisation of the province (Office of the Premier, 2020).

Rithu, Rahman & Al-Muruf (2016) argue that in secondary level education, the status of Geography and Environmental Studies is not taught optimally although students have some basic knowledge on the subject. The above scholars propose that modifying and simplifying teaching methods can enhance the quality of Geography and Environmental Studies education at secondary level. Mwenesongole (2009) proposes re-skilling and retraining of all educators involved in teaching mapwork in areas of basic skills to map reading and interpretation, basic mathematical skills and the importance of motivation. However, due to the current universal phenomenon of youth unemployability, the incorporation of technology in the teaching and learning of geographic skills becomes indispensable in the research community and necessitates a strong integration of technology in school-based geography curricula, known as the Curriculum Assessment and Policy Statements (CAPS) (Ontong & Khule, 2020), hence this study. To address the problem of youth employability, many researchers believe that the integration of technology in teaching and learning has the potential of producing good performance as learners have an opportunity to proceed at their own pace and review content according to their needs. In addition, technology allows learners to further receive reinforcement on some aspects of the content which gives access to a more challenging content, thereby providing complementary support for both teachers and learners (Nkomo, Daniel & Butson, 2021; Eneriz, 2019; Johnson et al., (2016); Ghavifekr & Rosdy, 2015).

2.9 Performance of Learners in Geography Mapwork Calculations

Studies have shown that students fail Geography as a subject because of their struggle with mapwork (Ahiaku, Mncube & Olaniran, 2016; Wilmot & Dube, 2016). Amosun (2016) revealed that students do not enjoy mapwork because the concepts are mathematical in nature. He adds that students avoid answering the questions on mapwork calculations. When they do, they answer them incorrectly. Mansaaray Examinations Council (WAEC) reported the same problem students face when attempting to answer mapwork questions in Geography. (WAEC, 2011, 2012 and 2013). Naxweka & Wilmot (2019) propose that professional development programmes be offered to support teachers in augmenting their curriculum and pedagogic content knowledge. However, those programmes should be theoretically informed. From the quantitative study that they conducted in Namibian secondary schools on the perspectives of teachers in teaching mapwork, they found that teachers focus on discrete map skills and procedural knowledge and pay scant attention to spatial conceptual understanding and knowledge application to solve geographic problems. They recommend addressing the issue of progression and under-specification of spatial conceptual knowledge.

The issue of attitude toward mapwork does not only affect learners, but even geography teachers suffer the same fate. Training teachers to use technology within the curriculum is important because it may help them in developing students’ positive attitudes towards technology (Khoza & Manik, 2015). Ahiaku & Mncube (2018) point out that attributes like teachers' qualifications and professionalism, among others, are essential to improve performance in the teaching of Geography. However, to meet the demands of the 21st Century, technology is seen as a focus of attraction to improve learners' academic performance and to augment the flexibility of public schools. Prinsloo, Rodgers & Harvey (2018) argue that while there are many factors that contribute to learners' poor performance despite large investments having been made, contextual factors are the major contributors to learner achievement. Contextual factors do not only involve physical resources that teachers need to execute their teaching practice, but also include the type of teachers who can empower learners in their quest for knowledge through technological means. While Munje & Maarman (2017) highlight other factors that contribute to poor performance apart from resources, they point out that capability limitations significantly influence the expected outcomes. These capabilities incorporate the use of technology to teach Geography in the current dispensation.

2.10 The Extent of Technology Integration in Teaching Mapwork Calculations

The way map work skills are taught in schools suggests that learners do not acquire and develop the necessary skills that could help them in their examinations and in their future careers (Larangeira and van der Merwe, 2016; DBE, 2015; 2016; 2017; 2018 and 2020). Currently, discussions focus on the integration of educational technology into instruction that will enhance sound learning experiences of diversified groups of learners. This calls for the need for technology-literate teachers who can demonstrate pedagogical knowledge (PK) through technology-integrated instruction, and who have a self-efficacy for implementing pedagogy through integrating technology with instruction (Estes, 2019). This is in line with Curtis' (2019) view who argues that the aim of teaching with Geographic Information Systems is to enable the learner to gain geographical skills and knowledge in relation to map work.

2.11 Local Initiatives in Technology Integration at Schools

The integration of technology in the teaching of subjects in schools is not uniform in all provinces and regions. There are several factors that cause the disparity as articulated in the KwaZulu-Natal Digital Transformation Strategy (2020). Despite the claim that KwaZulu-Natal has an opportunity to lead the country in digital transformation, several challenges are experienced in the province and countrywide. These challenges are expressed in the KwaZulu-Natal Digital Transformation Strategy (2020, p.3) document, and they include the following:

- The Digital Divide: differences in terms of race, class, gender, age, geographic location cause disparities in access to technology, and consequently deprive schools and provincial citizens of the opportunity to experience digital transformation.
- Silos in Government Departments: unequal functioning of the departments and other government entities cause fragmentation in service delivery which affect schools in various ways.
- Lack of Innovation: public sector institutions experience barriers in innovating service delivery mechanisms.
- Skills Shortage: the shortage of technology skills personnel hinders the digitisation process in schools.
- Limited Connectivity: under-serviced regions where many people in the KwaZulu-Natal province experience a lack of connectivity and access to internet. For example, from a total of 11 million people in KZN, only 1.8 million people have access to the internet.
- No Approved Strategy: to this day, there is no approved KZN Digital Transformation Strategy.

The current state of the province and the country does not allow the digital transformation initiative to run smoothly because of the above challenges that need to be addressed to facilitate the digitisation process. Limited progress is being made in the KZN province as the current MEC for Education is said to be handing over tablets to principals of schools in the education district.

A study titled, *A Snapshot Survey of ICT Integration in South African Schools* by Padayachee (2017) was conducted in Tshwane South Education District in the province of Gauteng. This study used a mixed method approach, and focused on the integration of technology in numerous subjects, not only Geography. The study argued that there was scant information on the practical enforcement of ICTs in the classroom and it could not generalise the findings beyond the thirty-four sampled teachers in the district where the study was conducted.

Ncube's (2018) study titled, *ICT integration in the teaching of FET Geography in Johannesburg East*, was situated in Johannesburg East, Gauteng. Although qualitative methods were used, it was contextually different and not content-specific, in that this study did not focus on mapwork calculations.

The study by Ahiaku, Mncube & Olaniran's (2019) titled *Teaching Mapwork in South African Schools: Reflections from Educators' Experiences, Concerns and Challenges*, only focused on the relevance of skills in cartography, and not on the extent of technology integration in the teaching of Geography mapwork calculations. This study was quantitative in nature and focused on Grade 12 teachers. The study found that the teaching of mapwork is a challenge to most of the educators sampled, especially the aspects that deals with calculations and GIS. Methodological gaps exist in the survey data obtained by means of a questionnaire since no in-depth exploration was conducted; only the extensive collection of quantitative data was done in terms of numbers. No interviews were conducted to obtain intensive and in-depth evidence of poor performances in relation to teachers' practice in the classroom.

A study by du Plessis' (2020) study titled, *A reflection on identified challenges facing South African teachers*, explored various challenges faced by teachers in school contexts. It is a comparative qualitative study located in three urban and three township schools. The findings reveal that teachers in South African public schools face many challenges despite the many positive developments in the education system. Using grounded theory, the study found, *inter alia*, many negatives in the system, from overcrowding in classrooms, poor learner performance, ill-discipline in schools to lack of resources. However, this study does not place specific focus on the integration of ICTs in the geographic location where this research took place. Moreover, the study recommends that the Department of Basic Education should slow down curriculum change and build from one curriculum to the next, taking only the best elements forward. It recommends the motivation of learners by dedicating the first thirty minutes of the first period to raise the level of reading in English. It encourages teachers to create workable solutions to overcrowding in classes and to facilitate efficient communication with parents, and so on. Although these are good recommendations, no attention was paid to the issue of technology integration in the teaching and learning environment.

Raksha Janak's (2019) PhD thesis titled, *Technology teachers' perspectives on the technology curriculum,* paid attention to the teaching of technology as a subject in schools, without any emphasis on the integration in other subjects. However, it revealed some important aspects hindering the efficient implementation of technology in schools, and further highlighted the inequalities existing between privileged and under-privileged South African schools.

Mkhize' (2020) research on *Geography teachers' perceptions of implementing paper-based geographic information systems in a rural learning ecology*, found that teachers are confined to using paper-based teaching of mapwork due to many factors that impact negatively on their teaching. The study found that challenges included inadequate teacher training, resources and financial constraints, lack of information, poor facilitating conditions and lack of teaching time, among others. However, the study is mute on the integration of technology in the teaching of mapwork calculations, but focuses on GIS as opposed to paper-based teaching of this theme. These conditions also hamper the efficient teaching of map work calculations, and result in poor learner performance which is evident from the Matric results.

To extend the argument on the integration on technology in the teaching of geography mapwork calculations in schools, more research is required on the integration of technology as proposed by the DBE in the White Papers of 2004 and 2016. The gap in the literature suggests that there appears to be a lack of recent evidence regarding the teaching of mapwork calculations in public schools in particular, although most of the learners are enrolled in these schools.

Felix's (2021) PhD Thesis titled, *Integrating Geography Teaching and Learning Using Information and Communication Technology*, investigated the integration of ICTs in the Intermediate phase of a primary school in South Africa. The findings of the study revealed that there is lack of policy provision regarding how teachers must integrate ICT in a geography classroom. It further identified a lack of proper training of teachers to implement ICTs in geography teaching. However, the findings in this study by Felix could not be generalised to all school settings, due to its nature being a case study confined in one school with a sample of two teachers from a primary school and focusing on the Intermediate phase.

This study focuses on technology integration within the Umlazi district, where there is a lack in much of the evidence regarding technology integration in teaching geography mapwork calculations. The following research questions will be investigated:

** What technologies are available for use by geography teachers at a secondary school in the Umlazi district to teach mapwork calculations?*

** How do geography teachers in the Umlazi District integrate the available technologies to teach mapwork calculations to grade 10 classes in the secondary school?*

** Why do Grade 10 geography teachers in this secondary school teach map work calculations? using the technology tools in the way that they do?*

This study aims to add value to understanding the role that technology plays in the teaching of mapwork calculations. In addition, this study will expose the reasons for the pedagogical choices that teachers make in teaching mapwork calculations in Grade 10 Geography.

2.12 International Initiatives

To make it possible for schools to incorporate technology, the UNESCO's Global Education Coalition highlights the critical role it can play in creating synergies to assist in rebuilding education systems globally and work towards digital transformation (UNESCO, 2021).

The United Nations Educational, Scientific and Cultural Organization's Competency Framework for Teachers (UNESCO-CFT) project was launched in 2012 as an initiative to accelerate progress towards the Education for All and the education-related Millennium Development Goals (MDGs). An additional funding from the Chinese government was made available to fund the second phase of the project that was launched from 2017 to 2018, with Togo and Zambia added to the original eight project countries. Phase Two builds on the achievements of Phase One to enhance the capacity of targeted national key teacher education/training institutions to provide quality teacher education and training (UNESCO-OER, 2019).

As late as 2019, numerous studies conducted in Namibia reveal that high school teachers lack the capability to use mobile technology as a pedagogical tool (Osakwe, et al, 2019). To address similar problems, many countries in the South Asia region have realised the need for training teachers in ICT use and have launched various professional development initiatives (Rahman and Ul-Aziz, 2019). The use of technology in education in developing countries is supported by models that seek to introduce and facilitate implementation and evaluation. Countries such as Chile, Costa Rica, India, Jordan, Malaysia, Macedonia, Namibia, Russia and Singapore follow the programmes of the World Bank through support structures to facilitate the use of e-Education in all the subjects offered in schools.

International studies have revealed the indispensable nature of using technology in the classroom to improve learner performance. Trepule, et al., (2015) assert that technology-enhanced learning has positive outcomes for learners who become central to their learning. Shah (2013, p.618) in his study on the use of technology in Pakistan secondary schools concluded that the “present day teacher is required to prepare the students for a highly competitive globalised world, equipped with far better professional, soft and life skills than ever before”. This makes technology to be an indispensable tool in teaching and learning as it does not only make the business of teaching and learning easier, but it also prepares learners for future integration into the global technology in the world of employment.

Findings from a published Master’s thesis by Wieking (2016) using the mixed methods approach in collecting data from Iowa schools in the United States of America, suggests that careful and consistent integration of technology in the classroom can impact positively on learners’ motivation to perform optimally in their studies. This confirms Mndzebele’s (2013, p.1) assertion that “technologies allow students to work more productively than in the past, but the teacher’s role in technology is more demanding than before”. A survey study for a PhD thesis conducted in three public schools in the Ashanti region of Ghana by Kankam (2017), revealed that learners lacked the competencies required for effective retrieval of online information. Since technology tools involve the use of the internet, it is essential for teachers to allow learners to retrieve information that will facilitate their understanding of mapwork in Geography. However, this requires internet connectivity as part of technology-enhanced teaching and learning in schools.

However, Biegon’s (2017) Master’s dissertation revealed a considerable improvement in the use of technologies in teaching and learning, but with a low level of use in the management of schools. The study revealed that secondary schools in Westbury-County have a 100% availability of desktop computers, 80% laptops, 90% printers and 60% internet connectivity. This is a significant improvement in a period of five years, though provision of resources does not imply utilisation of those resources. Kamau’s study concluded that where resources were available, they could not be used because of a lack of technology skilled staff and programmes installed in computers that were not intended for integration in all subjects.

Numerous studies have been conducted in various parts of the world. It has been established that the developed western world such as the USA, the United Kingdom (UK), Germany, France, Netherlands, Canada, and others, and in developed countries in the eastern world such as, *inter alia*, China, Japan, Russia, the integration is higher than in the developing countries of Africa and Latin America. The Sub-Saharan region has numerous challenges in relation to the infra-structure and training of teachers in technology integration.

2.13 Limitations in other Studies

The importance of using technology in the teaching of Geography in schools cannot be over-emphasised. However, it is important to reveal that Kadhim's (2020) study, using a systematic review research methodology, critically reviewed, and analysed 5 131 publications on the effective use of ICTs in the teaching and learning of Geography in a wide range of countries. His study on the "Effective Use of ICT for Learning and Teaching Geography" found that only eight publications qualified for the review and analysis. Disparities in the teaching and learning of Geography were found in the UK, USA and Australia. The study also found that teachers need to understand the relationship between Technological Pedagogical Content Knowledge (TPCK) and Geography subjects to teach them effectively. In addition, the study found that there were very few publications that used qualitative methodology to explore the use of technology in the teaching and learning of Geography. This is a serious limitation as the initiatives of the 21st Century by global governments and the private partners in education advocate the use of technology in education to facilitate development in various spheres of life.

Herring, Mishra & Koehler, (2016) indicate that the ability to find connections between studies is particularly important in the field of educational technology, where new technologies often lead to studies that appear to be new and specific to the affordances of particular tools and technologies. However, this study does not focus on affordances even though some of the participants in the focus groups and the semi-structured interviews indicated such. The research studies mentioned in 2.11 and 2.12 above do not address the issue of the integration of technology in the teaching of geography mapwork calculations in secondary schools in the Umlazi district.

2.14 Public-Private Partnerships for Technology Integration

In response to the United Nations Economic Commission for Africa's call on African countries to develop infrastructure on the continent to meet the challenges of the 4IR, the South African Government developed the Nine Point Plan for national growth in 2015. The national growth plan prescribed the establishment of an Independent Communications Authority of South Africa (ICASA) to facilitate government accountability based on technology and structural development indicators. The objective is to make use of these indicators to "benchmark values, inform sector policy analysis and to ensure compatibility with global benchmarking and data compiled by other regulators" (ICASA, 2020, p.5).

Private -Public-Partnerships were expected to facilitate technology integration programmes in schools involving private enterprises like Vodacom, Telkom and MTN (Isaacs, Roberts and Spencer-Smith, 2019; Vodacom, 2019; Telkom, 2015). Apart from laying the technology infrastructure, several workshops were organised at conferences to capacitate teachers and interested parties on Information, Communication and Technology for Development (ICT4D). Such conferences included the International Development Informatics Association (IDIA) and the Southern African Institute for Computer Scientist and Information Technologists (SAICSIT) held in 2014 and 2015, respectively (Turpin, 2018). Other development projects for technology in education include UNESCO-KFIT which aimed at developing technology infrastructure and programmes of empowerment in African countries and the world at large through set timelines. The e-Education Strategy 2013 -2025 was intended for projects in South Africa to integrate technology in the education system to improve the quality of teaching and learning on all levels of education, from basic education to higher education and training.

The initiative by network providers to assist the government in establishing connectivity in schools has motivated other private institutions such as Via Afrika Publishers to partner with the Education department to deliver Android-based training courses for teachers in a programme called Vadea (Via Afrika Digital Education Academy), which is hoped to equip teachers with high-technology (digital) skills.

The implementation plan was further reinforced by the ICT Policy Development Process in Africa. This process seeks to assess the extent to which African countries have included ICT issues in their national development policies and plans. In addition, it monitors the development and implementation of the National Information and Communication Infrastructure (NICI) policy and plans in different countries (Chavula & Chekol, 2011). South Africa incorporated the issue of ICT infrastructure development in its 2015 National Integrated ICT Policy White Paper, as laid down in its National Development Plan. The National Integrated Policy explains that “ICT will continue to reduce spatial exclusion, enabling seamless participation by the majority in the global ICT system, not simply as users but as content developers and application innovators” (DTPS, 2016).

To realise the 2030 vision, the DBE is required to develop the infrastructure to enable schools and higher education institutions (HEIs) to implement the use of technology networks to transmit information among teachers and between teachers and their learners. The implementation of infrastructure and provision of technological devices to both teachers and learners will affirm the realisation of the Nine Point Plan prescripts.

To accelerate the integration of technology in schools, the KZN Digital Transformation Strategy seeks to guide a common and coordinated response to benefit from the current digital revolution. South Africa, as one of the emerging economies, joined the BRICS countries in December 2010. BRICS countries, which includes developing states like Brazil, Russia, India, China and South Africa, proposed the comprehensive agenda in their 2019 Summit to include:

*Digital literacy

*Narrowing the social divide

*Digital skills development

*Digitalisation of small and medium enterprises

*Expansion in the development of inclusive digital projects within rural communities

*Coordination of business activities between public and private sectors

*Collaboration on knowledge and best practice sharing and enhancing digital connectivity

*5G (Fifth Generation mobile technology for broadband cellular networks) prioritisation

[Adapted from KZN DIGITAL TRANSFORMATION STRATEGY 2020-2025]

On the international scene, UNESCO, UNICEF, and the World Bank have joined together to assist various countries that are eligible for education sector programme implementation grants (EPSIG) from the Global Partnership for Education (GPE) to adopt evidence-based measures to respond to the COVID-19 pandemic. Several private organisations have committed to assist in financing the Global Education Project. However, the coalition contributions do not replace the existing national infrastructure that the education systems have built over the past decades but engages new actors that would not have been obvious partners (UNESCO, 2021b). Currently, the Global Education Coalition (GEC) has 175 partners, and operates in 175 countries worldwide, where it deploys a Global Skills Academy which aims to equip one million youths with employability skills, collecting large-scale data and advocacy like the Joint Global Survey on education response (UNESCO, UNICEF, WB and OECD, 2021).

2.15 Controversy regarding the Integration of Technology in Geography Teaching

By the end of the 20th Century, Pierson (1999) described technology integration as the use of content, technological and pedagogical expertise by teachers for the benefit of learning while Dockstader (1999) viewed technology integration as the enterprise about using computers effectively and efficiently in the general content areas to allow students to learn how to apply computer skills in meaningful ways. In 2018, Kimmons summarised technology integration as "the meaningful use of technology to achieve learning goals" (p.1) while Ntuli & Kyei-Blankson (2013) referred to it as the use of various digital and hardware tools to guide the process of teaching and learning in and out of the classroom. Kafyulilo et al., (2015) echoed the latter definition of technology integration and maintained that it is about using software supported by the business world for real-world applications, so that students could learn to use computers flexibly, purposefully, and creatively. No matter how these scholars define technology integration, the common denominator in their definitions is the 'use' or 'utilisation', which implies that without 'using' any of the technologies, the process of integration becomes invalid. Teachers and students have to 'use' technology to be perceived integrating technology in their teaching and learning enterprise.

The role of educational technology is seen as an important element for the efficient and enabling environment where effective teaching and learning can take place. Stošić (2015, p.11) emphasises that, "more than ever, the role of educational technology in teaching is of great importance because of the use of information and communication technologies". This is consistent with the DBE's (2004) "White Paper on e-Education: Transforming Learning and Teaching through Information and Communication Technologies" assertion that ICTs are central to the changes taking place throughout the world. This idea is further supported by

Kadhim (2020) who indicates that integrating ICTs in the teaching and learning of Geography can develop the Geographical Content Knowledge (GCK) of students, and that students' skills and knowledge in Geography are further expanded using remote sensing (RS) technology as a kind of technology tool used in geography education.

However, the implementation of educational technology within the South African schooling system is notably slow, and how technology is used in the classroom is largely unknown within South Africa (Sanders and Schoeman, 2019). This presents some controversy about the reality of the matter. Ncube's (2018) research found that a discrepancy between political rhetoric and the realities in the classroom concerning technology implementation and integration exists. The study revealed that preparation of teachers and learners to function in the new digital dispensation is not consistent with the current pace that the Government is moving in procuring electronic gadgets for schools. The study concludes that the discrepancy between Government's procurement and teacher training compromises the degree of technology integration in the teaching of Geography at secondary school level. The DBE expressed in its *2017/2018 School Monitoring Survey* (2018) that the role of Professional Learning Communities (PLCs) is becoming increasingly significant, and that both teachers and principals are realising the benefit of PLCs, and further claims that teachers who participate in these structures raise the issue of how PLCs can improve on teaching and learning. Furthermore, the DBE believes that PLCs can "make professional development more relevant and effective" (DBE, 2015, p.4). On the contrary, most of the teachers did not participate in these structures since there was no clear programme and the line of function was unknown to teachers. DuFour & Reeves (2016) conclude that these structures are not fully functional as they observed that "there are schools which purportedly have created professional learning communities, but do not fully implement the strategies real professional learning communities put into practice" (Brown, Horn & King, 2018, p.5). In some regions, the PLC structures do not exist at all, which implies that professional development of teachers is minimal, and this culminates in the poor integration of technology tools in pedagogic interactions. The integration of technology in pedagogic interactions in the classroom are well facilitated by the internet connection. Various structures, including, the Department of Telecommunications and Postal Services (DTPS), Vodacom, MTN, Cell C and Telkom, work together to implement internet connection by using policies already in place. For example, the South Africa Connect (SA Connect) is "the main government policy designed to connect public schools to fast and reliable internet" (Guruli, et al., 2020, p.9). This does not leave out the massive contributions of the Southern African Geography Teachers' Association (SAGTA) to improve the teaching of Geography in schools, provide resources and training to capacitate geography teachers with teaching expertise.

However, SA Connect was found to have been five times behind their connection schedule and the budget cuts by the National Treasury further deteriorated the connection problem (DTPS, 2016). The budget cuts of 82.9% in 2018/2019, and 75.9% both in 2019/2020 and 2020/2021 financial years implied a further delay in public school connectivity. The Universal Service and Access Obligations (USAO) is another second main initiative for connecting schools in South Africa, serving under the auspices of the key operators such as Vodacom, Cell C and MTN. However, many schools without sufficient funds to maintain connectivity and pay for their insurance of the devices have consequently failed to deliver on meaningful access to internet connectivity (Guruli et al., 2020). Furthermore, the Internet for All (IFA) initiative under the jurisdiction of the DTPS, depends on voluntary partnerships with the private sector and has no fixed annual budget. Consequently, it has failed to deliver on school connectivity. These structures and programmes have caused a significant backlog on technology integration in schools because schools cannot access the internet. In addition, the DBE failed to provide lists of unconnected schools to the operators, causing delays and a waste of resources, as some of the lists provided included schools that were already connected (Guruli et al., 2020). These factors negatively impacted on the integration of technology, not in Geography alone, but also in other subjects that schools offer.

Furthermore, the controversy is that the DBE claims to have 410 000 teachers on its employment database. The DBE further claims that the technology training sessions have been offered to 298 620 teachers out of the 410 000 currently qualified and employed teachers. This translates to 72.83% of teachers having been trained already. Yet, the provision of laptops has been made to 84 399 teachers across four provinces, being the Eastern Cape, Gauteng, KwaZulu-Natal, and the Northern Cape (March 2020 Portfolio Report). This fact concludes that there are 214 221 teachers without laptops in the classroom.

In addition, the digital content resources were set for other subjects offered in public schools in the FET phase, excluding History and Geography for the periods 2019/2020 and 2020/2021. The Report does not appear to be offering digital content for the two excluded subjects in the near future either. On the contrary, many of the learners in public schools, particularly in the former homelands, rural and township schools, take these subjects in the FET phase.

Geography remains the fifth most popular content subject of choice in the FET phase (Wilmot, 2018, DBE, 2020,2021), yet it appears that currently there has been no provision made to assist these learners.

The *2021 School Monitoring Survey* indicated that only 33.4% of KwaZulu-Natal public schools had computers in 2021 (DBE, 2021, NEIMS, 2021), with only 41.8% nationwide. On the contrary, the *National Education Infrastructure Management System (NEIMS) 2021 Report* reveals that only 7 676 of more than 24 000 schools nationwide have computer centres, with only 536 in KwaZulu-Natal having internet connectivity for teaching and learning (Table 2.6). Moreover, 66.6 % of schools in the province did not have computer centres. Even though KwaZulu-Natal had more schools than all other provinces countrywide, it ranked seventh countrywide among schools with computers centres (Table 2.5 below), while ranking fourth among schools that provided internet connection to their learners. The inability of the DBE to allocate computer centres to all schools in the KZN province renders it difficult for teachers and learners to acquaint themselves with computer applications as proposed in the policies of the *National Integrated ICT Policy White Paper* of 2016.

The availability of computer centres in schools increases access to the internet and to the required technology for both teachers and students. Computer centres or laboratories in schools provide workstation services, ensure equitable access, supplement classroom learning and promote collaboration among users. Irrespective of their allocated nomenclature, these computer centres remain important in providing access to internet and digital content in various fields of inquiry.

While there was a significant increase in the use of the internet by 4.5% in the 12-month period from January 2020 to January 2021, the use of social media applications also increased by 14%. Given the fact that more schools started to rely on social media to communicate messages and exchange other forms of textual data, audio and video messages, a significant increase of 0.8% in mobile connections was experienced in the same period. Table 2.7 on page 59 illustrates the increases in the use of the internet, social media and mobile connections in the general South African society when the COVID-19 pandemic was reported elsewhere in the world. The use of social media for educational purposes is not excluded in the table.

Table 2.5: Public Schools with and without computers in all SA's provinces

basic education
Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NEIMS
National Education Infrastructure Management System

Computer Centres Summary 12-04-2021 Table 9

Province	Number of Sites	With Computer Centre	% With Computers	Without Computer Centre	%Without Computer Centre
Western Cape	1457	882	60.54	575	39.46
Eastern Cape	5291	576	10.89	4699	88.81
Northern Cape	544	288	52.94	256	47.06
Free State	1084	431	39.76	653	60.24
KwaZulu Natal	5803	1938	33.40	3865	66.60
North West	1471	667	45.34	804	54.66
Gauteng	2074	1662	80.14	412	19.86
Mpumalanga	1718	657	38.24	1061	61.76
Limpopo	3834	575	15.00	3259	85.00
Total	**23276**	**7676**	**41.80**	**15584**	**58.16**

[Adapted from The NEIMS 2021Report, dated 12 April 2021]

Although some of the schools had more than one line of communication being used, it remained imperative to both teachers and learners that they access some of those technology tools for the benefit of teaching and learning in each site. Internet connectivity in schools is vital in accessing information for each subject to be presented efficiently, using technology tools. Internet connections allow both geography teachers and learners to access data in electronic maps, which facilitate an understanding of the concepts of scale as opposed to the two-dimensional maps that are usually common in schools. Xie (2019, p.85) argues that "scale is an important factor when considering reference maps, because scale directly affects generalisation and distortion level" when reading and interpreting maps, as well as doing calculations in mapwork tasks. Table 2.6 below shows the extent of connectivity in schools across the provinces of South Africa. Special attention is given to the schools in of KwaZulu-Natal where the research study took place.

Table 2.6: Schools with a single or more lines of communication in all SA provinces

Communication Source Facilities 12/04/21 Table 11

		Communication Systems Available								Without	
Province	**Number of Sites**	**Cell Network**	**Landline**	**Fax**	**Two-way radio**	**Internet Connectivity for Teaching and Learning**	**Internet Connectivity for Administrative Purposes**	**Public Call Box**	**Intercom**	**Total**	**Communi-Cation %**
Western Cape	1457	1098	1420	1331	98	1261	1292	654	186	1	0.07
Eastern Cape	5291	5161	1276	1066	40	570	1170	388	309	73	1.38
Northern Cape	544	500	421	391	10	215	408	61	82	1	0.18
Free State	1084	1027	868	817	29	303	391	437	58	5	0.46
KwaZulu Natal	5803	5609	2440	1821	55	536	1000	654	242	51	0.88
North West	1471	1444	640	549	10	276	650	138	96	3	0.20
Gauteng	2074	1762	1867	1743	131	1327	1441	990	495	1	0.05
Mpumalanga	1718	1625	872	594	2	99	241	118	3	19	1.11
Limpopo	3834	3782	882	537	5	151	345	152	34	24	0.63
Total	**23276**	**22008**	**10686**		**8849 1505**	**380 178**	**4738 0.55**		**6938**		**3592**

[Adapted from NEIMS 2021Report, dated 12 April 2021]

Geography is a broad and diverse field; however, geographers share a common geographic perspective to have an impact on the world. Joseph Kerski, education manager for Esri and 2011 president of the National Council for Geographic Education (NCGE) reiterates that "Geography enables students to understand their world locally and globally, making wise decisions about the planet and its resources, and become critical thinkers. Geography grapples with the key issues of our time, namely, energy, water, biodiversity, climate, natural hazards, population, and much more". In view of the opportunities that Geography students have in the field of work, it is quite important that they acquire spatial cognition and critical thinking skills that they will use in the job market. High competency skills in mapwork analysis are expected in the job market, which makes it imperative for secondary school learners to acquire this skill before they even pursue a tertiary education.

Apart from these computer applications that the DBE proposes for schools to teach Geography, there are other suitable educational mobile software applications that geography teachers can download to assist them in preparing for their geography lessons, worksheets, tasks, assignments, tests and examinations. Equipped with the necessary set of teaching software allows teachers to streamline their activities such as recording attendance and behaviour, and engaging students inside and outside the classroom with effective communication through mobile applications. Such applications can be used even in the recording and reporting of learners' achievements. Some of the software applications are designed to assist in the effective teaching of geography mapwork include GoogleForms, Edvoice, Prezi, YouTube.com/EDU, GoogleMaps, GeogSpace, Google Lit Trips and Map Your Memories. These are some supportive software applications that can also assist teachers in their lesson presentations, and include TED, Pocket, Edx, Blue flashcard quizzes, Seesaw, Edmodo, Trello, Remind, Tick, Noon Academy, Dropbox, Slack, and Google classroom. Furthermore, some of the software applications are designed for use by learners, and include Extramarks and Quizizz. Extramarks is a learning software application aimed at empowering learners through rich, animated lessons which make learning exciting and engaging. Quizizz is a free learning tool that allows teachers to conduct student-paced formative assessment in a fun and engaging way for learners of all ages.

It is noted that some software applications are designed for use by the immediate stakeholders such as teachers, parents, and learners, and include Evernote, DIKSHA, ClassDojo and Kahoot.

The Southern African Geography Teachers' Association (SAGTA), through its massive contributions to the teaching of Geography, also provides electronic content in the form of maps and related activities to promote effective teaching and learning of the subject in all grades. Mapwork downloader is one of the electronic contents provided by SAGTA.

The increase in the utilisation of technology has been manifested in the rise in using social media platforms since the spreading of the pandemic in 2020. Table 2.7 below reflects data on the increase in the use of social media platforms, the internet connectivity, and the mobile connections in South Africa. It is apparent that most members of the schooling community resorted to using features in their devices and maintain connection to continue the process of teaching and learning during the severe lockdown period from 2020 to January 2021.

Table 2.7: An increase in the use of social media during the COVID-19 pandemic.

1.	Total internet users in SA	N=Increase in internet users	% Increase of internet users	Internet penetration	Period:
	38.19 million	1.7 million	4.5	64.0 %	January 2020 to January 2021
2.	No. of social media users in SA	N=Increase in SM users	% Increase of SM users	Social Media penetration	
	25 million	3 million	14	41.9%	
3.	Mobile connections in SA	N=Mobile Connections	% Increase in Mob. Cons	Mobile Connections penetration	
	100.6 million	817 000	0.8	168.5%	

2.16 Enhanced Teaching and Learning

The use of radio, television and mobile phones in the classroom and at home is considered important tools that can enhance teaching and learning of Geography in secondary schools since, as Burns & Santally (2020, p.58) will argue, "they are technologies that people own and know how to use". The interactive radio instruction (IRI) or the interactive audio instruction (IAI) technologies are claimed to have been the most successful teaching and learning tools in schools in Sub-Saharan Africa over the past four decades. Currently, the addition of social media platforms in teaching and learning has added several benefits to the education sector. Bonsu et al., (2020) assert that the gradual adoption of technology in the classroom to make teaching and learning worthwhile has been evidenced during the COVID-19 pandemic, particularly in developing countries. Even though most of the studies conducted before the advent of COVID-19 have focused on the use of technology in schools (Shambere, 2014; Aburub & Alnawas, 2019), the new challenge is the use of technology to enhance teaching and learning during and post-COVID-19 period. The pandemic brought a new urgency to schools and researchers to navigate new ways of teaching and learning which necessitated the implementation of blended learning, involving technology tools. Hence, the importance of this study.

2.17 Assessment in Geography Mapwork Calculations

Maps are key aspects in Geography and the assessment of the subject relies on the understanding of mapwork and the mastering of complex calculations. The ability to read and interpret maps is part of visual literacy (Schoeman, 2018), and it is a vital skill that requires considerable time and effort for both geography teachers and learners. The Diagnostic Reports have revealed that some teachers are not well versed in mapwork calculations (DBE, 2018; 2019. 2020) and display a low level of mapwork literacy (Innes, 2012). The general performance of learners at Grade 12 level bears testimony to these results. As recently as 2020, Grade 12 learners achieved 59% on average in mapwork calculations in the multiple-choice question of Paper 2. They achieved 42% in the actual map calculations and techniques and 48% in application and interpretation. Their mapwork calculations results are provided per topic in Table 2.8.

Table 2.8: A synopsis of average performance of Grade 12 learners in mapwork calculations in 2020

Calculating:	Contour interval	89%	Average gradient	47%
	Grid reference	50%	Magnetic bearing	42%
	Distance	38%	Cross-section, intervisibility and vertical exaggeration	40%

The Report indicated that learners "could not differentiate between the scale used in the orthophoto map and the one used in the topographical map" (DBE, 2020, p.118). As a result, their responses were faulty as they used the incorrect scale. The DBE proposed that learners be exposed to and practise calculation steps and marks allocated to every step. The teachers needed to "familiarise themselves with the marking guidelines" (DBE, 2020, p.119). It is further proposed that mapwork should be integrated with the teaching of the theory component. Correct assessment strategies need to be followed right from inception in the FET phase to inculcate sound mapwork skills.

Assessment in Geography is the gathering of evidence which measures a student's knowledge and understanding, and is integral to the teaching and learning process (NZ Ministry of Education, 2018). The DBE (2011, p.49) defines assessment in Geography as "a continuous, planned process of identifying, gathering and interpreting information about the performance of learners, and may take various forms". Assessment is the systematic collection, review, and use of information about educational programs undertaken for the purpose of improving learning and development (Palomba & Banta, 1999, p.4). Different forms of assessment are followed in teaching and learning, and they include informal, diagnostic, formative and summative assessments. The timeframes at which assessments take place determine the form of assessment being implemented. A comprehensive programme will include both formative and summative assessments. The DBE (2011, p.49) distinguishes between formal assessment and informal assessment, conceptualising the former as all assessments that make up the formal programme for the year and the latter as the daily monitoring of a learner's progress which could be done "through observations, in discussions, during practical demonstrations in learner-teacher conferences and in informal classroom interactions".

Diagnostic assessment is done prior to instruction and is a form of pre-assessment to allow a teacher to determine the strengths, weaknesses, knowledge, and skills of a learner before teaching and learning takes place (Esomomu & Eleji, 2020; Suzuki, 2013). Assessment in the South African system of education is based on "The National Protocol on Assessment for Schools in the General and Further Education and Training Band" as espoused in the Revised National Curriculum Statement (RNCS) in 2005. Assessments call for both formal and informal forms with recorded pieces of evidence regarding learner performance throughout the schooling age and reporting to the relevant bodies of authority. Geography mapwork calculations form part of the geography teaching and learning programme and are required to be assessed formally, recorded, and reported, with substantial feedback to learners and parents. For this reason, mapwork calculations are examinable pieces of evidence in the formal curriculum in all phases.

2.18 Integration of ICTs in the Assessment of Geography Mapwork Calculations

The use of technology in the teaching of geography map work is believed to benefit learners and improve the level of performance and that if technology is not integrated it may have negative effects on the learners' performance (Moga & Obuba, 2017; Padayachee, 2017; Isaacs, Robert and Spencer-Smith, 2019; Kadhim, 2021). The integration of technology has become an indispensable tool in the teaching of geography map work calculations to prepare learners for the 21st Century challenges. Integration of technology in the assessment of geography mapwork calculations necessitates a shift from traditional to modern or advanced forms of assessment which could be regarded as the next generation or digital form of assessment. Table 2.9 below introduces the constructs on which traditional and digital forms of assessment rest across the education spectrum.

Teachers use formative assessments to identify gaps in students' understanding, 'inform and improve instructional practices, while students use formative assessments to track their own learning' (Office of Educational Technology, 2021). Summative assessments are normally conducted in a formal setting at the end of term, semester, or year. Technology-based assessments enable teachers to use a variety of question types beyond the limited multiple-choice, true-or-false type of questions, or fill-in-the blank options that characterise traditional assessment formats. On the other hand, technology-based assessment allows students 'to demonstrate complex thinking' (Office of Educational Technology, 2021) while sharing their understanding of the material that traditional assessments could not provide. Table 2.9 below compares the two modes of assessment, i.e., traditional and future assessment techniques and the interpretation of constructs that both systems are based on.

Table 2.9: Constructs of traditional and digital forms of assessment (Adapted from EdTech)

	TRADITIONAL	**NEXT GENERATION**
Timing	After learning	Embedded learning
Accessibility	Limited	Universally designed
Pathways	Fixed	Adaptive
Feedback	Delayed	Real-time
Item types	Generic	Enhanced

[Adapted from EdTech]

2.19 Conclusion

This study is vital as it seeks to determine the extent of the integration of technology in the teaching of mapwork calculations, since there is no recent study that has been conducted in Umlazi Education District in KwaZulu-Natal regarding the current state of adoption of technology in the teaching of mapwork calculations. The proposed study aims to understand the role of technology in the teaching of mapwork calculations to Grade 10 Geography learners by considering the teachers' pedagogic practice. There is a need to determine the experiences of these teachers as they may have a direct impact on the performance of learners. Some studies have been conducted in other geographical locations within the country. However, a geographical lacuna has been identified. Furthermore, a population gap exists since the targeted population has not been specifically Grade 10 Geography teachers, but teachers in the FET phase. This study focuses on Grade 10 teachers because a Grade 10 class forms the foundation for the FET curriculum. This is where Geography and History diverge as individual subjects, from having been a single subject collectively referred to as Social Sciences, from the Intermediate to Senior phase. Moreover, geography skills and techniques are put into practice from this grade and are linked to specific topics (DBE, *CAPS Document*, 2011). This makes Grade 10 an imperative stepping-stone towards the successful completion of the phase.

Literature points to the direction of positive results when technology is integrated into the teaching of geography mapwork in secondary schools (Ontong & Khule, 2020; Vassallo & Warren, 2018; Moga & Obuba, 2017). Milson (2021, p.10) indicates that "not only are students more likely to understand geographic concepts and acquire spatial thinking skills when they engage in technology enriched lessons but will also enjoy the subject more". However, there are challenges regarding the proper implementation of technology tools in the teaching of the subject. Lack of access to internet connectivity in many public schools and the lack of teacher training and attitudes to the use and integration of technology have been identified as major problems that hamper the integration process in schools, particularly in geography classrooms (Mannova & Preston, 2017; Ahiaku & Mncube, 2018; Naxweka & Wilmot, 2019; Priva, 2019; Guruli et al (2020; Kadhim, 2021). Nonetheless, there is confidence that with more effort on the part of all stakeholders in education, improvement is imminent.

CHAPTER 3

FRAMING THE STUDY CONCEPTUALLY AND THEORETICALLY

3.1 Orientation to the chapter

This chapter introduces the two conceptual frameworks that will be applied in analysing the sampled teachers' integration of technology into geography mapwork through their application of content knowledge (CK), pedagogical knowledge (PK) and technological knowledge (TK). The teachers' knowledge is vital for the successful teaching of mapwork calculations in schools and maximum achievement of the learning outcomes. The performance of learners relies much on the way mapwork calculations are taught and the strategies used to impart mapwork literacy, as well as the development of spatial cognition to the learners. Assessment strategies that teachers use contribute to learner performance. However, strategies used in geographical inquiry are believed to encourage questioning, investigation and critical thinking about issues affecting people's current and future lives (Lambert and Bolderstone, 2010). The integration of technology in the teaching of geographical aspects like remote sensing (RS) and Geographic Information Systems (GIS) is believed to engage and develop the learners' knowledge and skills (Kadhim, 2020; Ghavifekr & Rosdy, 2015). The two conceptual frameworks, namely, Unified Theory of Acceptance and Use of Technology (UTAUT) and the Technological Pedagogical Content Knowledge (TPACK), will be described in this chapter and will be applied to data analysis (Chapter 6).

3.2 The Conceptual Models

The preceding chapter presents a conceptual framework which covers a summary of empirical studies that relate to the introduction and integration of technology in the teaching of geography mapwork, and provides a theoretical base for the current study. The current study explores how teachers integrate technology in the teaching and learning of geography mapwork calculations at secondary schools. The rationale for using the two theories is that each of the models covers some aspects of how teachers integrate technology in teaching. This also provides information in creating an understanding of the integration of technology and the practice of teachers in the classroom as a social group. A comprehensive and extensive conceptual framework is therefore necessary to provide a clear understanding of technology integration and the experiences of geography teachers as they integrate technology in their geography mapwork lessons, particularly in calculations.

3.2.1 The Unified Theory of Acceptance and Use of Technology (UTAUT)

The UTAUT is a theoretical model based on the Technology Acceptance Model (TAM) formulated by Venkatesh, Morris, Davis and Davis (2003). The model aims to explain the intentions of a user utilising the information system and the behaviour adopted in using the system. The theoretical model is well-known for its four key constructs that explain the process of technology adoption, namely, performance expectancy (PE), effort expectancy (EE), social influence (SI) and facilitating conditions (FC). The UTAUT is an extension of the TAM model to include other factors that play a vital role in the process of technology adoption. TAM was first introduced by Davis in 1986, based on the Theory of Reasoned Action (TRA) developed by Fishbein and Ajzen in 1975 (Davis et al., 1989). The main objective of the model was to understand what motivates users of technology to choose a specific technology item and reject other types. TAM is an information systems theory that models how users accept and use a technology (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989). To reach the stage of technology acceptance, the behavioural intention has to be established, leading to the use of an invention (Wibowo, 2019). The behavioural intention (BI) is influenced by attitude and the general view and feeling about the preferred type of technology. UTAUT as the extension of TAM was used to assess the user's attitude towards new technology and the ability of the user to utilise the technology that has been accepted (Ayman, 2015). The use of this model would assist in framing the teachers' responses to the questionnaire used in the pilot study regarding the teacher's experiences in accepting and using technology in their teaching of geography mapwork calculations.

Figure 3.1 below illustrates the influences of performance expectancy (PE), effort expectancy (EE), social influence (SI) and facilitating conditions (FC) on the behavioural intentions of participants in technology integration, namely, Grade 10 geography teachers. The factors, namely, gender, age, experience and voluntariness of use impact on the four variables at different level and intensity, thereby contributing to the behavioural intentions of the participants in technology integration. The behavioural intentions influence the participants to use the type of technology at their disposal for their own benefit or for the benefit of others.

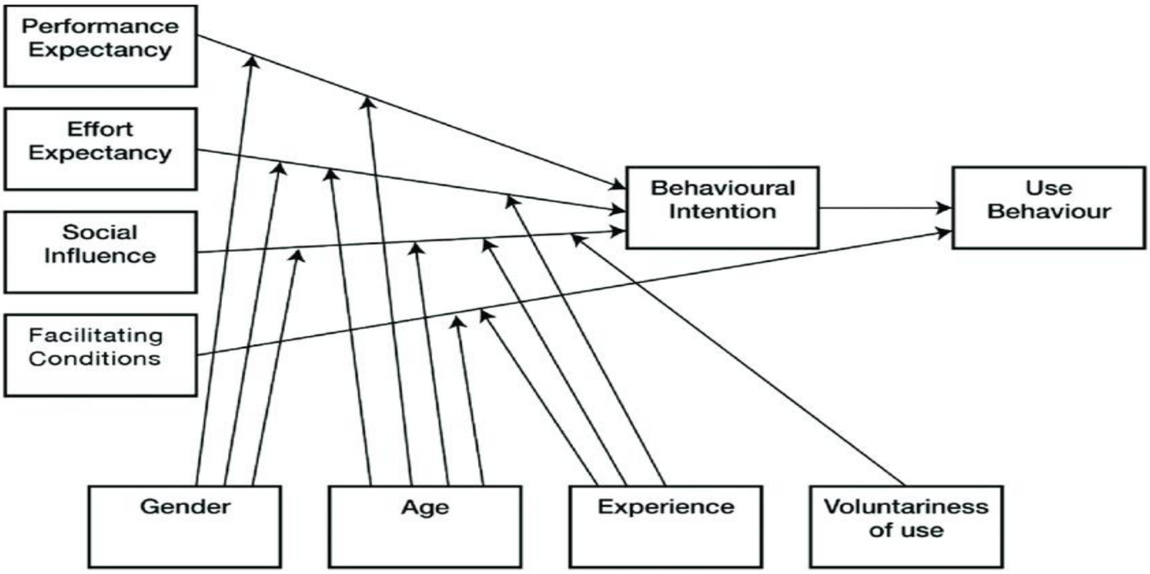


Figure 3.1: Unified Theory of Acceptance and Use of Technology Model

In this study, the four concepts mentioned above will be used as a conceptual framework to analyse the collected qualitative data. A concept "summarises ideas or observations about the characteristics of a mental image about a phenomenon" (Van der Waldt, 2020, p.2). In this sense, concepts present a high degree of abstraction, where the literal meaning of the word is not important, but the progressive level of abstraction takes precedence. The focus is rather on the usage of a word in particular settings, argues Van der Waldt (2020). When using a conceptual framework in research, conceptualisation of the words becomes vital as it requires the "building of the level of sophistication to define concepts" (Kumar, 2014, p. 57). The concepts used in the UTAUT model will be methodologically used as constructs to analyse qualitative data. The term 'construct' will be used to indicate the level of abstraction at which the term is used.

Venkatesh et al., (2003, p.447) define performance expectancy as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance". It is at this level at which a person considers whether the use of new technology would assist in improving his or her work performance. In the original TAM model, this is labelled as perceived usefulness (PU), which (Ayman, 2015, p. 3) defines as "the degree of ease associated with the use of the system". This is where the user perceives the new technology as easy to use, free from effort (Davies, 1989), and is equated to perceived ease-of-use (PEOU) in the original TAM (Sullivan, 2016). In this study the term analyses the way teachers perceive the use of technology in the teaching of geography mapwork calculations. The participants' responses to the qualitative questionnaire themes 2, 3 and 4 of the questionnaires revealed the positioning of self-evaluation of their technological pedagogical knowledge (TPK) regarding the integration of technology in the teaching of mapwork calculations.

The construct 'social influence' will be used in this study to analyse the influence of new technological trends that have been adopted by the community of practice, namely the geography teachers. Both Venkatesh (2003, p.451) and Ahmad (2015, p.15) define social influence as "the degree to which an individual perceives how important it is that others believe he or she should use the new system". The construct 'social influence' is fundamentally explained as a moderator of the influence on behavioural intention by gender, age, experience, and volunteers of system (Ayman, 2015). Rathinaswamy et.al., (2020) caution that the notion that technology can only be used for the purpose of trade, is deceitful in the contemporary world. Technology is used for teaching and learning, and by various structures and individuals within the education spectrum in general. The construct will be applied to the focus group and semi-structured interview data analyses.

Facilitating conditions are said to be moderating the influence on behavioural intention by age and experience. The construct 'facilitating conditions' is defined by Venkatesh et al., (2003, p.453) and Ahmad (2015, p.3) as "the degree to which an individual believes that an organisational and technical infrastructure exists to support use of the system". These are the conditions a user believes are adequate for the system to be employed effectively and include organisational readiness and infrastructure adequacy (Sullivan, 2016). The construct applies specifically to the analysing of the conditions at the research site where observations, document analysis and semi-structured interviews were conducted. Nonetheless, the construct also applies to focus groups where geography teachers express their views on the conditions at their respective schools.

3.2.2 The Ability of UTAUT to explain the Study

In using the TAM, Sullivan (2016), evaluated the correlation of the neuroticism personality type as measured by the five-factor model (FFM) with the acceptance of TKMS as measured by the TAM. Barrick & Mount (1991) described the neuroticism personality dimension as an inclination to anxiety and frequent change of mood, resulting in fearfulness and depression. The study concluded that persons high in neuroticism are less accepting of TKMS than those low in neuroticism, based on its perceived usefulness or perceived ease-of-use, and is said to be beneficial to the employers. Consequently, the researcher proposes that employers employ workers low in neuroticism as they more readily accept the move to new technological advancements. Moreover, Raja, Johns & Ntalianis (2004, p.354) concluded that employees high in neuroticism are likely to focus on short-term exchanges with their employer in relation to performance, particularly on tasks not requiring high initiative. These researchers further concluded that employees high in neuroticism tend to focus on the successful completion of the tasks and becoming a significant part of transactional contracts with their employer. The use of TAM in Sullivan's (2016) study proved to be useful in analysing the attitudes, openness and agreeableness to use new technological innovations.

Numerous studies have shown how the UTAUT model is adequately used in the field of education. For example, Dwivedi et al., (2017) critically reviewed the theory against an alternative theoretical model, where they used a combination of meta-analysis and structural equation modelling (MASEM). Basing their meta-analysis (MA) on 1600 observations from 162 prior studies, the structural equation modelling (SEM) analysis revealed that attitude was core to behavioural intentions (BI) and usage behaviours (UB). The researchers concluded that attitude (AT) had a direct influence on usage behaviours while partially moderating the effects of exogenous constructs on behavioural intentions (BI). Exogenous constructs are the performance expectancy, effort expectancy, facilitating conditions and the social influence. However, the fact that the researchers effected some improvements on the UTAUT theoretical model to serve their specific objective for understanding the acceptance and use of Information Technology, did not invalidate the value of the original version of UTAUT in educational research. Hence, the model is selected for use in this study.

Mutlu & Der's (2017) study on the acceptance of mobile phones and smart phones in Turkey aimed at understanding the main determinants of TAM. These researchers sought to test the model for the adoption of mobile messaging applications, especially fast messaging. Despite the study being based on the theories of adoption and diffusion of innovations, the framework for UTAUT theory was preferred for the explanation of the consumer adoption process. Quantitative methods in the form of questionnaire were used to solicit data from smartphone-users who also used mobile internet to access fast messages.

Three constructs were added to the four exogenous constructs of the TAM model, namely, Hedonic Motivation (HM), Price Value (PV) and Habit (HB). Hedonic motivation is defined as the enjoyment or happiness resulting from using a technology (Mutlu & Der, 2017, p175).

Venkatesh, Thong, and Xu (2012, p. 161) define HM as “the fun or pleasure derived from using a technology”. It is beyond question that most members of society, particularly the youth and learners, find pleasure in using mobile devices and technology in general. Hence, Brown and Venkatesh (2005) assert that hedonic motivation plays a vital role in BI by influencing individuals to accept the use of technology. The price value (PV) construct is described by Venkatesh et al., (2012) as the cognitive balance between the perceived benefits and the monetary cost of using these. Both teachers and learners are perceived to be more interested in using smartphones and other advanced technological devices available for use in educational transactions. Both are likely to base their benefit in correlation to the cost of the device, that is, the more expensive the device, the more sophisticated and useful it may be.

3.3 What is a TPACK Framework?

Technological Pedagogical and Content Knowledge (TPACK) is a framework that is based on Lee Shulman’s theoretical construct of pedagogical content knowledge, but with the inclusion of technology (Mishra & Koehler, 2009). In other words, the TPCK was introduced to the educational field of research as a theoretical framework for understanding teacher knowledge required for effective technology integration (Mishra & Koehler, 2006), into teaching and learning. The framework describes how teachers understand educational technologies and how the pedagogical and content knowledge interact to produce effective teaching through the use of technology. The framework is represented by the following model, illustrating the interactions between the conceptual understandings.

TPACK is said to be based on the three bodies of knowledge, namely, content knowledge, pedagogy, and technology. This implies that the knowledge of the subject content that a teacher possesses (content knowledge) must find a way of expression in a specialised environment (pedagogy) using the latest ways to make transmission easier (technological knowledge). Graham, Borup and Smith (2011, p.3) describe TPACK as “a framework that proposes a set of knowledge domains involved in integrating technology into teaching”, citing Mishra & Koehler (2006; 2008). According to Graham, Borup & Smith (2011), the foundation of TPACK is the pedagogical content knowledge (PCK). The PCK lays the foundation upon which TPACK is developed as expressed in Figure 3.2 adapted from Graham, Borup & Smith (2011).

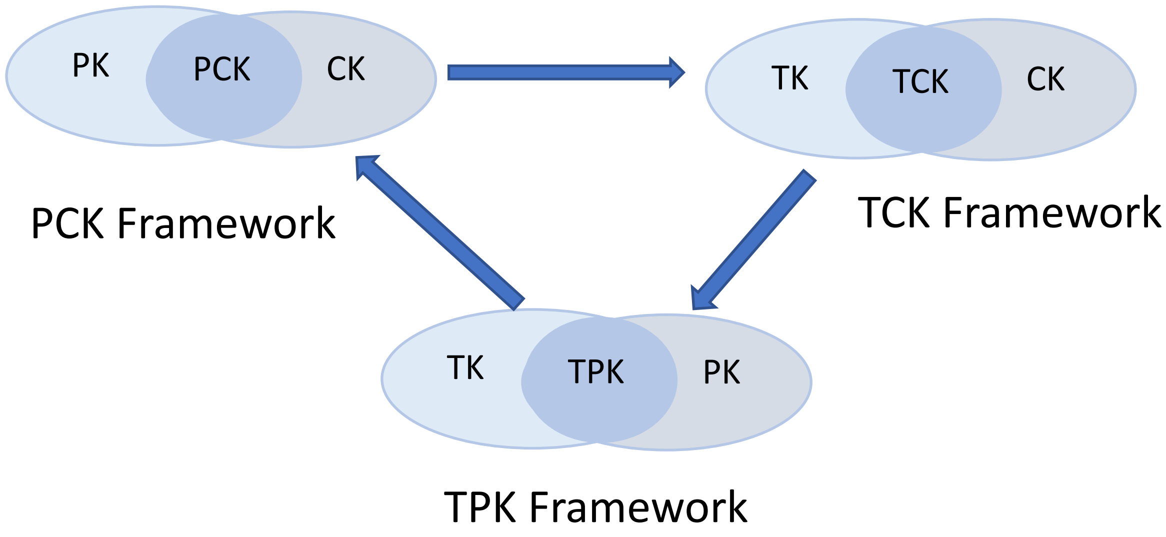


Figure 3.2 Technological Pedagogical and Content Knowledge Framework

These categories are foundational in explaining the nine models which include eight categories as identified by Lee & Tuft (2008), namely, the subject matter, representations and instructional strategies, general pedagogy, student learning and conceptions, curriculum and media, context, purpose and assessment. Consistency is recommended for technology integration in the teaching and learning of subjects in line with the planning and decisions a teacher makes to determine curriculum-related activities to support learning, as well as the type of technology to be used to support the selected learning activities (Harris et al., 2009). Graham, Borup and Smith‘s (2012) study indicates that when using TPACK as a framework to understand the technology integration decisions of teacher candidates, very few showed a deeper understanding of the subject content. While a very few coding categories focused on the learners' prior knowledge, most claimed that the use of technology would improve their understanding of the content.

The TPACK model comprises seven theoretical constructs which include technology knowledge (TK), content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK) and technological pedagogical content knowledge (TPCK). The latter is the combination of the four constructs as discussed *supra*. The model is presented in figure 3.3 below:

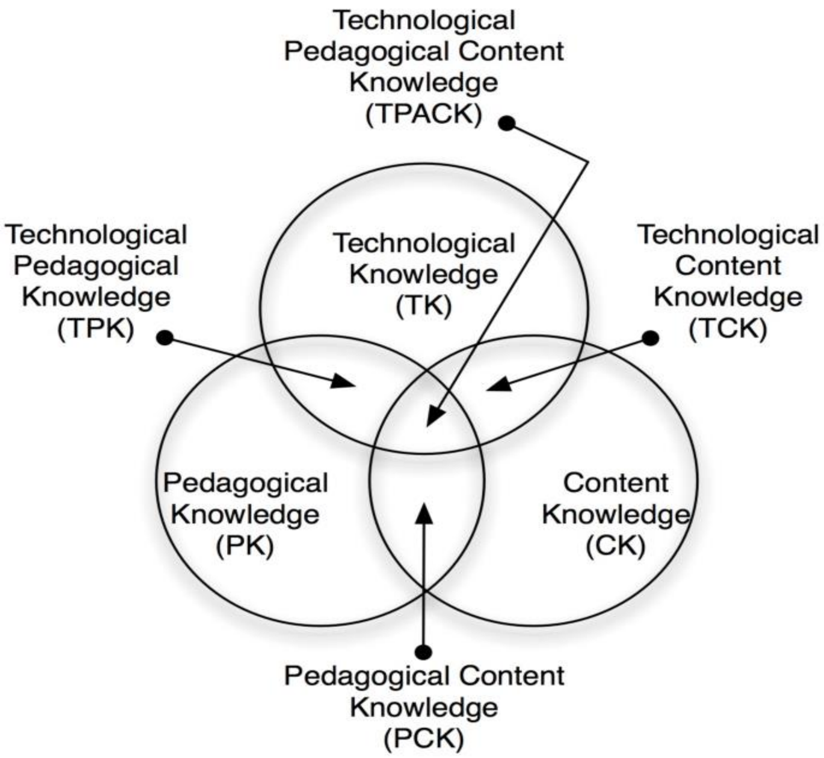


Figure 3.3: The Technological Pedagogical Content Knowledge (TPACK) Model

Technology knowledge (TK) is the knowledge and mastery of technology that enables teachers to plan and use technological devices and software programmes in the classroom for the benefit of both teacher and learners in the sharing of the subject content. Smidt et al., (2009, p.125) refer to this construct as "the knowledge about various technologies, ranging from low-tech technologies such as pencil and paper to digital technologies such as the Internet, digital video, interactive whiteboards, and software programs". Ndongfack (2015) asserts that TK goes beyond digital knowledge but includes knowledge of how to refocus the purpose of existing technologies so that they can be utilised in technology-enhanced setting.

Content knowledge (CK) is the knowledge of the subject content which includes concepts, theories, ideas, frameworks and evidence, and the knowledge of how that content is constructed. Mishra and Koehler (2006, p.1026) describe this as the "knowledge about actual subject matter that is to be learned or taught". Furthermore, Schmidt, et al., (2009) opine that those teachers must know the content they are going to teach and conceptualise the nature of knowledge as it differs for various areas of the subject. It is in the interest of the subject or subject theme that teachers are required to deliberate on the presentation of the content. Geography teachers, during their preparation for the class, need to consider the strategies they can employ to effectively deliver the content and the assessment procedure they will present to validate the learners' understanding of the content. The strategies they use in different content areas will vary according to the requirements of each theme. For example, in mapwork calculations, two-dimensional or electronic maps are indispensable. Conversely, the nature of the knowledge content determines the strategies for effective delivery of the content and the type of assessment strategies teachers can use to effectively assess the level of acquisition of the content by learners. The level of difficulty of the subject content varies with the level of education which makes it necessary for a teacher to firmly master the content to cope with the increasing levels of difficulty in line with the grade level (Ndongfack, 2015).

Pedagogical knowledge (PK) is the knowledge and practice of teaching and learning that a teacher uses to share subject content with learners. This knowledge includes taxonomies, classroom management, planning and assessment. Schmidt et al., (2009, p.125) define pedagogical knowledge as the "methods and processes of teaching and includes knowledge in classroom management, assessment, lesson plan development, and student learning".

Pedagogical content knowledge (PCK) is the knowledge that combines the pedagogy and the subject content to bring about a strong subject knowledge imparted through systematic and purposeful teaching and learning strategies. Pedagogical content knowledge refers to the content knowledge that addresses the teaching process (Shulman, 1986). Schmidt et al., (2009, p.125) assert that "pedagogical content knowledge is different for various content areas, as it blends both content and pedagogy with the goal being to develop better teaching practices in the content areas".

Technological content knowledge (TCK) is the knowledge that combines the knowledge and skills of technology with the knowledge of subject content to promote a robust subject knowledge that is imparted though sophisticated technological means. TCK refers to the "knowledge of how technology can create new representations for specific content. It suggests that teachers understand that, by using a specific technology, they can change the way learners practice and understand concepts in a specific content area" (Schmidt et al., 2009, p. 125).

Technological pedagogical knowledge (TPK) combines the knowledge of how and when to use a range of tools and their appropriateness in teaching and learning specific content within the knowledge of subject content. It leads to an understanding of how teaching and learning can change when technological tools are used in particular ways to assist teaching and learning. Schmidt et al., 2009) describes TPK as the knowledge of how various technologies can be used in teaching, and to understanding that using technology may change the way teachers teach.

Ndongfack (2015, p.1703) asserts that "TPK requires an understanding of general pedagogical strategies applied to the use of technology". The way a teacher applies the technological tool in the teaching of a particular subject content will reveal the extent of a teacher's technological pedagogical knowledge.

Technological pedagogical content knowledge (TPACK) is the knowledge and understanding of how best a teacher can teach (PK) the subject content (CK) using technology (TK) to transform learning with the aim of achieving the set learning outcomes. Schmidt et al., (2009, p.125) define TPACK as it refers to the "knowledge required by teachers for integrating technology into their teaching in any content area". Knowing how various technological tools can be used in teaching and learning (TPK) does not automatically translate into integrating the tools in teaching. Integration of technology entails specific skills that geography teachers need to develop to successfully apply in teaching and learning situations (TPACK).

Teachers have an intuitive understanding of the complex interplay between the three basic components of knowledge (CK, PK, TK) by teaching content using appropriate pedagogical methods. TPACK forms the core of teaching and learning where technology is used to facilitate well-thought-out strategies to deliver the content knowledge of a subject to the learners.

The integration of technology in teaching and learning has long been on the forefront of much scholarship and "the introduction of the TPACK framework has served to integrate many lines of research while focusing on the interplay between content, pedagogy and technology" (Herring, Koehler and Mishra, 2016, p.404). In the same vein, the TPACK framework serves to analyse the data from participants and is believed to yield trustworthy findings in this study. However, the approach that perceives technology integration from the perspective of the TPACK framework, shifts the focus away from affordances and constraints of technologies to content-based pedagogy and student needs. It remains important to analyse data from participants in the light of connections between the constructs of the TPACK against other studies that have been conducted in the field of educational technology.

3.3.2 The Ability of TPACK to explain the Study

Numerous research studies in psychology and in education have used TPACK to analyse the practices of practitioners and teachers, respectively. This study employs the model to analyse the practices of Geography teachers in the integration of technology as they teach, using a variety of technological tools to facilitate learners' understanding of mapwork calculations.

TPACK will be used to analyse the data from the focus groups, questionnaires, and semi-structure interview data. The themes derived from the data generated from these instruments will be analysed to determine the practices of teachers. These will include the experiences of geography teachers in teaching mapwork calculations, knowledge acquired from teacher training workshops, attitudes of teachers towards the use of technology, the resources available to facilitate the use of technology and the aims of using technology, to mention but a few. The TPACK framework assists in viewing the themes that developed from coding through a specific lens. A theoretical lens in qualitative analysis is a framework that provides explanations, and methods of the individual's experiences of phenomena in the world (Moore, 2006).

3.4 Relevance of the Models in Qualitative Research

Both the Unified Theory of Acceptance and Use of Technology (UTAUT) and Technological Pedagogical and Content Knowledge (TPACK) focus on the adoption and use of technology. The UTAUT model developed after combining eight adoption theories and is believed to be a reliable and useful tool in understanding new technological diffusions and adoptions (Rathinaswany et al., (2020). Abbad (2020) believes that the UTAUT model provides a valuable tool that enables decision makers and designers to understand the factors that drive the acceptance of e-learning and facilitate the adoption of the system by students.

The integration of technology in the teaching of geography mapwork in secondary schools as envisaged in this study is important in preparing learners for the outside world after school and coincides with the development skills necessary for the 21st Century. Moreover, numerous jobs today require technical and technological skills which learners need to acquire. In view of the opportunities that geography students have in the field of work, it is important that they acquire spatial cognition and critical thinking in combination with the technology that they will use in the job market. High competency skills in mapwork analyses are requirements in the job market, which makes it imperative for secondary school learners to acquire before they pursue tertiary education.

The use of the two models will yield trustworthy results as they will triangulate the data. In addition, these frameworks have been used in many studies concerning the use of technology. For example, The UTAUT was used by Abrahao, Morguchi & Andrade in their 2016 research study, *Intention of adoption of mobile payment: An analysis in the light of the Unified Theory* *of Acceptance and Use of Technology (UTAUT)*, in south-eastern Brazil to evaluate the intention of adopting a future mobile payment service by Brazilian mobile phone customers. A survey method was used to collect data from 605 participants. Data was analysed using the structural equation model against the UTAUT constructs, from which 76% of behavioural intention was explained through performance expectation, effort expectation, social influence and perceived risk. The results revealed that the perceived cost for using mobile phones was found statistically not significant at the level of 5%.

Other studies using the model include *inter alia*, Mutlu and Der's (2016) *Unified Theory of Acceptance and Use of Technology: The adoption of Mobile Messaging Application*; Dwivedi et al., (2017)'s study, *Re-examining the Unified Theory of Acceptance and Use of Technology: Towards a Revised Theoretical Model;* Abbad's (2020) study, *Using the UTAUT model to understand students' usage of e-learning systems in developing countries*.

The TPACK model has also been used in a variety of quantitative and qualitative studies and proved to be efficient in analysing both quantitative and qualitative data. In the study by Schmidt et al., (2009), *Technological Pedagogical Content Knowledge (TPACK): The Development and Validation of an Assessment Instrument for Preservice Teachers*, the internal consistency reliability (coefficient alpha) ranged from .75 to .92 for the seven TPACK subscales. According to George & Mallery (2001), this range is perceived to be from acceptable to excellent. In Phillipsen, Tondeur & Zhu's (2015) qualitative research study, *Using TPACK to Examine Teacher Professional Development for Online and Blended Learning*, the TPACK framework provided meaningful insight into teachers' necessary knowledge requirements for technology integration. Azgin & Senler's (2017) study employed a survey method, and the data was gathered by using the TPACK Assessment Instrument. Findings were analysed using the t-tests and the one-way ANOVA tests. The results showed that there is no significant difference in teachers' scores of the instrument in terms of class size, class type, and graduated department.

Furthermore, Utama et al., (2019)'s literature review study, *Using TPACK as a framework to analyse TLC model*, found that the Technology Learning Cycle model separates the components of technological knowledge (TK) from content pedagogical knowledge (CPK) which implies that the separation of knowledge domains has an impact on the obscurity of the use of technology in learning using the TLC model. These studies confirm the validity of the model as it has been used in various studies and successfully produced trustworthy and valid results both qualitatively and quantitatively. The use of the TPACK model in this research study will not inhibit any flaws in producing trustworthy results.

3.5 The Theories behind Research in Technology Integration

There are common theories used in analysing the processes of technology integration in the teaching of various subjects in school, and include constructivism, behaviourism, cognitivism and connectivism. However, these theories have certain shortcomings, although they are intended to analyse the effective integration of technology during teaching in the classroom. In addition, three perspectives commonly used in analysing technology integration include diffusion of innovations (DoI), TPACK and SAMR. DoI is a "social process that occurs among people in response to learning about an innovation that is communicated through certain channels over time among members of a social system" (Dearing & Cox, 2018, p.183; Rogers, 2010). This theory describes how members of society adopt an innovation, idea or product over time and how they make decisions regarding the adoption of the new innovation. TPACK, explained in detail above, draws attention to the forms of knowledge that teachers need to effectively integrate digital technologies into their practices. SAMR abbreviates the four terms, proposing the levels of effective integration of technology, namely, substitution, augmentation, modification, and redefinition. Phillips (2015, p.12) defines SAMR as the "framework that allows you to consider the effectiveness of digital technology use in different classroom activities".

In this study, TPACK is used as a theory of personal attributes conversant with the interplay of four constructs representing expert knowledge that a teacher uses to teach in the classroom. The four constructs of this model were used in the analysis of teachers' practices at the research site. UTAUT as a theoretical model was also used to describe and explain how technology is integrated at the research site. However, some moderators in the model, such as behavioural intention, attitude and use behaviour, were complemented by constructs from the technology integration model. This assisted the study to explore every facet of the process and develop a clear understanding of how technology integration is facilitated in the school. This was feasible as Dwivedi et al., (2017, p.719) indicate that "some moderators in the original UTAUT model may not be applicable in all contexts". This study, however, uses constructs from the technology integration model as they effectively explained some of the factors that better facilitated the integration. Nonetheless, the exogenous constructs in the model, namely, performance expectancy, effort expectancy, facilitating conditions and social influence, were fully employed in the analysis, although they might be "viewed as perceptions held by individuals regarding the technology and the context" (Dwivedi et al., 2017, p.179).

3.6 Theoretical Contributions to Technology Integration in Geography Mapwork Teaching

A repertoire of constructs from the three models forms part of the causes for technology adoption and rejection, or rather, the inability to integrate technology in the teaching of geography mapwork calculations, as illustrated in the TePaSig Model (see Figure 6.13 in Chapter 6). The variables of the technology integration model (TIM) reveal connections of theoretical constructions developed by several scholars who explored the processes of technology adoption and integration in school subjects and the curricula in general. The conceptual constructs and variables explained in Table 3.1 below were used in various studies in relation to technology integration.

The fourteen variables described below contribute to the theoretical formation of Technology Integration Model (TIM). The theoretical construct of variables expressed in column 2 in the Table 3.1 have approximately the same meaning as the ones in column 3, expressed in italics. The scholars mentioned in the same column (2) used the variables in their publications. The meaning of each variable is given in the last column. These variables have been used in the development of the theoretical model expressed in Chapter 7 (Figure 7.1).

Table 3.1: Variables of technology integration model (TIM) and Unified Theory of Acceptance and Use of Technology (UTAUT)

No.	**Theoretical construct/ variable**	**Theorists linked to the model/variable (their alternative use of the term)**	**Meaning of the construct/ variable**
	Ease of Use	*Effort Expectancy* (Venkatesh, Morris, Davis & Davis, 2003; Venkatesh, Thong & Xu, 2012), *Perceived Ease of Use* (Kim & Malhotra, 2005; Davis, Bagozzi & Warshaw, 1989; Venkatesh & Davis, 2000), *Objective Usability* (Venkatesh and Bala, 2008) and *Technicality* (Setterstrom, Pearson & Orwig, 2013).	Effort, ease, or difficulty of performing a technology use behaviour.
	Pre–Use Evaluations	*Attitude* (Kim & Crowston, 2011; Davis, Bagozzi & Warshaw, 1989), *Performance Expectancy* (Venkatesh, Morris, Davis & Davis, 2003; Venkatesh, Thong & Xu, 2012), *Perceived Value* (Setterstrom, Pearson & Orwig, 2013) and *Result Demonstrability* (Venkatesh & Davis, 2000; Venkatesh & Bala, 2008).	Evaluating the technology before use.
	Behavioural Intention	*Behavioural Intention* (Kim & Malhotra, 2005; Davis, Bagozzi & Warshaw, 1989; Venkatesh & Davis, 2000; Venkatesh, Morris, Davis & Davis, 2003; Venkatesh, Thong & Xu, 2012; Venkatesh, Thong & Xu, 2016) and *Continuance Intention* (Limayem, Cheung & Chan, 2003; Setterstrom, Pearson & Orwig, 2013; Bhattacherjee, 2001).	A person's intentions to use the technology.
	Technology Use Behaviours	*System Use* (Kim & Malhotra, 2005; Davis, Bagozzi & Warshaw, 1989), *IS Continuance* (Limayem, Cheung & Chan, 2003) and *Use Behaviour* (Venkatesh & Davis, 2000; Venkatesh, Thong & Xu, 2012).	Actual technology use.

	Context	*Environmental Attributes*, *Location Attributes*, *Events* (TIME) and *Organisational Attributes* (Venkatesh, Thong & Xu, 2016).	Contextual factors that could influence use.
	Support	*Perceptions of External Control* (Venkatesh & Bala, 2008), *Facilitating Conditions* (Venkatesh, Thong & Xu, 2012; Venkatesh, Morris, Davis & Davis, 2003; Venkatesh, Thong & Xu, 2016), and *Organisational Attributes* (Venkatesh, Thong & Xu, 2016)	Support mechanisms available, which could aid the use of the technology.
	Extrinsic Motivations	*Perceived Usefulness* (Kim & Malhotra, 2005; Limayem, Cheung & Chan, 2003; Setterstrom, Pearson & Orwig, 2013; Bhattacherjee, 2001; Davis, Bagozzi & Warshaw, 1989; Venkatesh & Davis, 2000), *Job Relevance* (Venkatesh & Davis, 2000; Venkatesh & Bala, 2008), *task attributes* (Venkatesh, Thing & Xu, 2016) and *Objective Usability* (Venkatesh & Bala 2008).	Practical advantages of using the technology to complete specific tasks.
	Intrinsic Motivations	*Enjoyment* (Setterstrom, Pearson & Orwig, 2013), *Uncertainty Avoidance* (Setterstrom, Pearson & Orwig, 2013), *Affective Reaction* (Kim & Crowston, 2011) *Perceived Enjoyment* (Venkatesh & Bala, 2008) and *Hedonic Motivations* (Venkatesh, Thong & Xu, 2012); Mutlu and Der (2016).	Internal experience that is the result of using the technology or the enjoyment or happiness resulting from using a technology.
	Habit	*Repeated Behavioural Patterns* (Kim & Malhotra, 2005) and *Habit* (Limayem, Cheung & Chan, 2003; Setterstrom, Pearson & Orwig, 2013; Kim & Crowston 2011; Venkatesh, Thong & Xu, 2012; Venkatesh, Thong & Xu, 2016).	Habitual mechanisms which drive technology use or the extent to which people tend to perform behaviours automatically because of learning.
	Individual Differences	*Experience* (Venkatesh & Davis. 2000; Venkatesh & Bala, 2008; Venkatesh, Morris, Davis & Davis, 2003; Venkatesh, Thong & Xu), *Computer Self Efficacy* (Venkatesh & Bala, 2008), Computer Anxiety (Venkatesh & Bala, 2008), *Computer Playfulness*	Attributes of the user which may influence the use of a technology.

		(Venktesh & Bala, 2008), Gender (Venkatesh, Morris, Davis & Davis, 2003; Venkatesh, Thong & Xu, 2012), Age (Venkatesh, Morris, Davis & Davis, 2003; Venkatesh, Thong & Xu, 2012) and *User Attributes* (Venkatesh, Thong & Xu, 2012).	
	Post-Use Evaluations	*Feedback Mechanisms* (Kim & Malhotra, 2005) *Sequential Updating Mechanisms* (Kim & Malhotra, 2005), *Confirmation* (Limayem, Cheung & Chan, 2003; Bhattacherjee, 2001), *Satisfaction* (Limayem, Cheung & Chan, 2003; Bhattacherjee, 2001), Cognitive Reaction (Kim & Crowston, 2011) and *Output Quality* (Venkatesh & Bala 2008; Venkatesh & Davis, 2000).	Evaluating the technology after use, which may influence future behaviour.
	Price	*Perceived Fee* (Setterstrom, Pearson & Orwig, 2013) and *Price Value* (Venkatesh, Thong & Xu, 2012).	Monitory costs associated with using the technology.
	Social Factors	*Subjective Norms* (Kim & Crowston, 2011; Venkatesh & Davis, 2000; Venkatesh & Bala, 2008), *Image* (Venkatesh & Davis, 2000; Venkatesh & Bala, 2008) and *Social Influence* (Venkatesh, Morris, Davis & Davis, 2003; Venkatesh, Thong & Xu, 2012).	A user's perceptions of how others view them if they were to use the technology or the degree to which an individual perceives that important others (family and friends) believe he or she should use the new system.
	Mandatory Use	*Voluntariness* (Venkatesh & Davis, 2000; Venkatesh & Bala, 2008; Venkatesh, Morris, Davis & Davis, 2003).	If the user perceives using the technology to be mandatory.

[Adapted from: Dwivedi, Y.K., Rana, N.P., Jeyaraj, A., Clement, M. & Williams, M.D. (2017); Abrahão, R., Moriguchi, S.N. & Andrade, D.F. (2016)]

3.7 Conclusion

The use of the two models as the conceptual framework for this study is aimed at bringing about an understanding of how teachers use technology to teach mapwork calculations to geography learners. Geography teachers' experiences will be analysed using both the UTAUT and the TPACK. The constructs of the models will be used as frameworks to analyse the themes that developed from the focus groups and semi-structured interviews, as well as to analyse the questionnaire geography teachers at the research site completed regarding their familiarity and experiences with TPACK in their classrooms. However, the analysis will be qualitative, and some quantitative elements may be necessary to authenticate the results.

To analyse qualitative data obtained from participants, a Thematic Content Analysis (TCA) was used. Anderson (2004, p.1) defines TCA as "a descriptive presentation of qualitative data". Qualitative data in this study takes the form of interview transcripts collected from the focus groups and semi-structured interviews with the participants. Other data was collected from textual documents requested from participants at the research site. Observational data were textualized following the observation of teachers in practice during the geography periods in Grade 10 classes. This form of data will also be analysed using TCA. Thematic data analysis is "a qualitative data analysis method that focuses on identifying patterned meaning across a dataset (Braun and Clarke, 2006, p.1; Hayes, 2018). In analysing the qualitative data, the six steps will be followed as presented in Chapter 4, Section 4.16.4. This analysis involves coding and developing themes and the interpretation will be kept at minimum level as Anderson (2004) suggests.

CHAPTER 4

METHODOLOGICAL CONTEXT OF THE STUDY

4.1 Orientation to the chapter

This is a qualitative research study which attempts to explore and understand the integration of technology in the teaching of geography mapwork in secondary schools. Qualitative methods are employed to explore the phenomenon. Five methods of data production are used. The rationale for using these qualitative methods is to triangulate the study and ensure that the findings of the study are trustworthy to the research community. The methods employed in the study involve the use of a qualitative questionnaire, focus groups, semi-structured interviews, observations and document analysis. These data generation methods attempt to yield in-depth analysis through rich description of the findings. Ethical considerations were observed throughout the research process, taking cognisance of the ethical clearance boundaries stipulated by the University of KwaZulu-Natal Research Office.

4.2. Research Design

According to Kumar (2015), a research design is a plan, structure and strategy of investigation conceived to obtain answers to research questions or problems. This coincides with Davis and Bezuidenhout’s (2014) suggestion that research design enables one to anticipate how to collect information that will respond to the research question/s about a particular phenomenon. In other words, it is a master plan specifying the methods and procedures for collecting and analysing the needed information.

This study follows a qualitative research design approached from an interpretivist perspective to understand the teaching and learning of geography mapwork calculations in view of promoting the integration of technological tools in Grade 10. The interpretive paradigm relies on how the researcher interprets reality, using mental constructions to provide an understanding of the bounded system that governs reality in time and place. In this approach, a case study method was preferred to ensure the use of multiple sources of information, and that all the methods used to generate data, employ direct observations, semi-structured interviews and practical document analysis (Scholz & Tietje, 2013) could be integrated. The researcher used this design because there was a need to study a group or population, identify variables that can then be measured, or hear silenced voices (Creswell, 2004). It was therefore important to explore a problem in its natural setting rather than to use predetermined data from other sources or to rely on other research studies. To understand the complex and detailed nature of the phenomenon under study, this qualitative inquiry is indispensable. The study explored the extent of the integration of technology, invariably referred to as the Information and Communication Technologies (ICTs), in the teaching of mapwork calculations by the said teachers in a public secondary school to determine whether teachers used the tools in their pedagogic interaction with learners.

The study presents an interpretive approach to the phenomenon in trying to understand the current status quo in relation to the teaching of mapwork calculations in secondary schools. The interpretive paradigm, also referred to as a constructivist paradigm, recognises the importance of the subjective human creation of meaning but does not outrightly reject some notion of objectivity (Baxter & Jack, 2010). The constructivist paradigm rests on the assumption that truth is relative and that it is dependent on one's perspective, just as Cashman (2008) argues that people form or construct much of what they learn through experience. As this approach was used, the researcher remained mindful that this paradigm "does not aim to predict what people will do, but rather aims to describe how people make sense of their own worlds, and how they make meaning of their particular actions" (Creswell and Poth, 2017, p.217). This paradigm assisted the researcher in attaining an in-depth understanding of the current use of technology to teach mapwork calculations and enable the researcher to understand how teachers interacted with their learners using technology. The participants provided their own interpretation of what technology integration meant to them and how they anticipated their integration in cases where they did not use technology in their pedagogic interactions with learners. Participants were sampled using the electronic calculator and the Krejcie & Morgan table. The quantification of the qualitative data emanates from the need to administer the qualitative questionnaire. Quantifying the qualitative data is acknowledged in qualitative studies as Drozdova & Goubatz (2016) indicate.

4.3 Research Problem

Most of the learners in South African secondary schools generally perform poorly in Geography in the FET phase, particularly in the aspect of mapwork, which makes up 60 marks of the total mark for Geography Papers 1 and 2, that is 30 marks for each paper. This makes up 20% of their final Geography examination paper from Grade 10 up to matriculation level. The examination question on mapwork is further sub-divided into *Map skills and Calculations* which amounts to 10 marks; *Map interpretation* (12 marks) and *Geographic information systems (GIS)* which amounts to 8 marks. The problem does not begin at Matric level, but becomes evident in the earlier grades as learners commence their FET phase in Grade 10, where Geography becomes insulated from History, as discussed earlier.

Most teachers use traditional methods of teaching in public secondary schools, which may have a negative effect on the performance of learners in Geography Education and mapwork calculations, in particular (DBE, 2018; 2019; 2020). The DBE has proposed the use of educational technology tools to improve both teachers' and learners' performances. From personal knowledge, there is no latest research evidence regarding the extent of the use of educational ICT tools, in schools within the Umlazi Education district in KwaZulu-Natal.

According to the studies conducted from 2015 to 2020, learners taking Geography do not perform optimally in mapwork calculations at Matric level (Ncube, 2018; Ahiaku, Olaniran & Mncube, 2019; Kadhim, 2020; Ontong & Khule, 2020; Mkhize, 2020; Felix, 2021). The DBE Diagnostic Reports reveal that performances in Geography have not exceeded 60% in the last six years (DBE, 2015; 2016; 2017; 2018; 2019 and 2020). Learner performance in Geography has been attributed to several factors at public secondary schools. Recent research studies also point out several factors that contribute to this condition. du Plessis's (2020) findings identified, *inter alia*, challenges such as curriculum change, medium of instruction, overcrowded classrooms, discipline and lack of resources, poor subject content foundation, mark adjustment and condonations, underqualified teachers and lack of access to internet, that has led to poor learner performances.

Despite these problems, it is believed that the use of technology in the teaching and learning environment will set a new trend and raise the level of performance in almost all the subjects in schools (Kadhim, 2020; Fleischman & van der Westhuizen, 2020; Bindu, 2016). Padayachee's (2017) study points out that teachers are uncertain with respect to the enforcement of e-education while being encumbered by poor infrastructure and lack of skills. This is supported by a study by Ahiaku, Mncube, & Olaniran (2019), which reveals that the teaching of mapwork is a challenge to most educators, especially the aspects that deal with calculations and GIS. They point out that factors such as educators' qualifications, educators' preparedness and inadequate teaching and learning resources were responsible for the poor mapwork teaching among educators. This is consistent with the study by Kafu-Quvane (2021) which concludes that teachers have more negative experiences with technology integration than positive ones. These negatives include insufficient technology resources, timetable clashes in using the equipment, a lack of technology skills, inadequate training in technology integration, negative attitudes, and a lack of confidence in using the gadgets.

My observation is that there is also the problem of a lack of IT support for the teachers at many of the schools and thus, the computers are not maintained properly or remain unfixed for a long time. Some schools have computer rooms and, teachers and learners often use the PCs for games and so on. In that way, they incur viruses or purposely vandalise them, or steal some equipment that maintain connections to the servers.

The aim of this study is to gain an understanding of the integration of technology, following the persistence by the DBE that teachers should use technology tools in their teaching. It is evident in the DBE's multiple documents, namely, "White Paper on e-Education (2004)", "National Integrated ICT Policy White Paper (2016)", "Report on the Provision of ICT and e-Education with a Focus on Connectivity (2016)" and the "Action Plan to 2019: Towards the Realisation of Schooling 2030 (2018)", which prioritise the integration of technology in schools. The aim is to ensure that learners are equipped and prepared to live and work in today's complex society that is confronted by the 4IR. Yet, Kafu-Quvane (2021) concludes that efforts to incorporate ICTs in the curriculum do not appear to be as successful as envisaged.

This study therefore aims to determine the extent of the integration of technological tools in the teaching of geography mapwork calculations in order to understand the reasons for poor learner performance at Matric level in the said geographic area. The research questions that the study will attempt to answer are:

* *How do geography teachers in the Umlazi District integrate the available technologies in their teaching of mapwork calculations?*
* *What are the available technologies that geography teachers use in the Umlazi district?*
* *To what extent do Grade 10 geography teachers integrate technology in the teaching of mapwork calculations in a secondary school in KwaZulu-Natal?*
* *Why do Grade 10 geography teachers in secondary schools teach mapwork calculations in the way that they do?*

In response to the first question, the focus was placed on how technology is used to effectively teach geography mapwork calculations. In addition, the kinds of technologies that geography teachers use in the classroom to ensure effective teaching of geography mapwork was also considered. In responding to the second question, it was considered whether the use of technology in Geography is motivating for learners. The practice of teachers using technology in teaching Geography was explored in the same question.

The researcher used the UTAUT and TPACK as theoretical lenses to investigate the practice of geography teachers in answering the research questions. Qualitative data was solicited from participants by conducting focus group interviews with Post level one educators and individual semi-structured interviews with geography teachers at the research site. Document analysis was conducted, following direct observations of teachers in practice, to obtain primary and secondary data from the teachers' records and files.

4.4 Sampling

Sampling is the act, process or technique of selecting a representative part of a population for the purpose of determining parameters or characteristics of the whole population (Merriem-Webster Dictionary). A purposive sample is described as "a non-probability sample that is selected based on characteristics of a population and the objective of the study" (Crossman, 2018, p.1). In view of the use of the qualitative questionnaire to collect data, the qualitative data had to be quantified to solicit data from the participants in the district. Nonetheless, this did not change the data from being qualitative in nature (Drozdova & Gaubatz (2016).

A sample consisting of 120 out of 173 secondary schools in the district was determined, using electronic calculators, viz. Qualtrics, Survey system, Smart survey, Calculator.net and Survey Monkey. In addition, the Krejcie and Morgan table was used to select the sample size. The sample was calculated at 95% confidence level (CL) and 5% Margin of Error (MoE). The list was obtained from the 2021 DBE database.

The confidence interval (CI) is defined as the range of values that one expects the estimate to fall between a certain percentage of the time if the experiment was re-run or the population was re-sampled in the same way (Bevans, 2020). In quantitative studies, the confidence level is usually 95%, and the margin of error 5% (Pandey & Pandey, 2015; Julious, 2019). However, this research is qualitative and cannot follow the procedures used in quantitative research studies. Drawing from the sampling frame involving all the secondary schools in the said district, a sample of 120 schools was researched. This sample was solely used to glean data concerning teachers' integration of technology in teaching mapwork calculations without using statistical analysis. The qualitative questionnaire was used to solicit qualitative data from participants since it was not feasible to hold interviews with many participants due to the COVID-19 pandemic restrictions. More in-depth data could be obtained by administering a qualitative questionnaire.

Table 4.1: Electronic Calculators used to determine the sample size

	MoE = 5%	**Electronic Calculator**
CL = 95%	120	Qualtrics
	119	Survey System
	119	Smart Survey
	120	Calculator.net
	120	Survey Monkey
Total Schools in the District		173 Secondary schools
Sampling selection		(2^{nd} x 3^{rd} x 5^{th})

The number of schools in the sample was calculated from the sampling frame of schools as they appear in the district's database. A sampling frame is a list of all eligible members of a population from which samples are drawn (Sandhana, 2020; Jung, 2020). A sampling frame may include individuals, households, or institutions. In this study, the sampling frame included Grade 10 geography teachers as representing their respective institutions, namely, secondary schools in the district.

A sample list was created for easy selection from the data-list of schools. Firstly, every second name that appeared in the sampling frame was included, However, the list could not reach the number required for the complete sample. Secondly, every third name of a school in the sampling frame was selected. Again, the required sample could not be reached. Thirdly, every fifth school was selected, which ultimately attained the full sample. The qualitative questionnaire was administered to participants from the listed sampled schools. Consent letters were sent to the principals for their permission to conduct the survey. Teacher-participants signed the informed consent and were sent an electronic copy of the questionnaire. However, the response rate was very low, and the researcher resorted to visiting the teachers in person and handed over hard copies, which were collected by arrangement.

4.4.1 Sampling the Participants to Focus Groups

Three focus groups were created to discuss questions about the integration of technology as they appeared in the focus group schedule. One focus group was comprised of six Grade 10 teachers, one was comprised of five teachers, and one was comprised of four participants who were all purposively selected to participate in the study (refer to Table 4.2 on page 94 below). Informed consent was requested from each of the participants and consent was also requested at the regional Geography cluster level. Consent from principals of the selected schools was sought to allow the researcher to interact with teachers in their respective schools. Focus group discussions were scheduled to take place via ZOOM or SKYPE. Where it was not possible to use technology, the researcher interacted with participants and devised a way to communicate via a focus group.

Purposive sampling was used to select participants in a school where the researcher would conduct semi-structured interviews and document analysis, i.e., Grade 10 geography teachers from the Department of Humanities/Social Sciences. Two interviews were conducted with the two participants at the research site. One interview was conducted remotely via the WhatsApp platform due to COVID-19 restrictions, and a telephone interview was conducted where it was not feasible to use the WhatsApp platform. Both interviews were recorded using a voice-recorder and later transcribed for analysis.

4.5 Methodological Approach

As mentioned, this qualitative study uses an interpretative paradigm to explore the research problem in its natural setting. The researcher employed the case study method to describe the context of the study for purposes of data collection. A case study is a research strategy and an empirical inquiry that attempts to investigate a study phenomenon within a real-life context and is based on the principle of an in-depth investigation of a single group or events to explore and understand the underlying causation principles (Annan, 2019). The case study method is relevant in this research as it allows for the solicitation of in-depth and intensive data that would yield a comprehensive understanding of how participants relate to and interact with their learners in a classroom, and how they construct their teaching programmes that integrate technological tools for the transfer of geographic skills to learners as well. Case study research allows the researcher to explore and understand complex issues within a bounded system in terms of location and time frame. It is for this reason that a case study is regarded as a robust research method when an in-depth investigation is solicited. It was imperative that this research followed a case study methodology as it is more expressive, explorative, and circumstantial in its design and purpose, therefore, enabling the generation of a rich description of explored phenomena (Creswell & Poth 2017; Yin 2013).

4.6 Justification of Using a Case Study Method

A case study is used to identify the key concepts to answer research questions. It is used to glean evidence as to how ICT is used as an effective method of learning and teaching Geography at the research site. To get an understanding of the problem, it was necessary to investigate the practices of numerous schools and focus on the practices of the best performing school. Data was solicited through closed- and open-ended questions from 106 schools in the district by means of a qualitative questionnaire. The objective was to solicit evidence pertaining to the Grade 10 teachers' practices in their schools in relation to the integration of technology in their teaching of mapwork calculations. After analysing the responses from the questionnaires, a clear picture of what was happening in schools, in general, was emerged. Document analysis and semi-structured interviews assisted to obtain more data from the research site.

Many researchers maintain that it is best to adopt methodological triangulation in research studies so as to increase trustworthiness and confirmability of the results. Triangulation is the method used to increase credibility and validity of the research findings (Cohen, Manion & Morrison, 2000). Noble & Heale (2019, p.67) further clarify that it is "an effort to explore and explain complex human behaviour by using a variety of methods to offer a more balanced explanation to readers". This study employs a variety of data generation methods, namely qualitative questionnaires, focus groups, semi-structured interviews and document analysis to explore teachers' experiences in their interaction with learners, and their teaching of geography mapwork calculations.

4.7 Triangulation of Qualitative Methods

The use of the four above stated methods of data collection, will allow triangulation of the results. It is important to triangulate the data generation methods because triangulation "can enrich research as it offers a variety of datasets to explain differing aspects of a phenomenon of interest" (Noble & Heale, 2019, p. 67), and allows objective explanation of the complex human behaviour. Furthermore, interviews and focus group discussions do not provide an objective scrutiny of the teachers' practices, particularly as no classroom observations could be conducted during the COVID-19 pandemic.

Using a qualitative questionnaire and document analysis in this study brought about a considerable degree of credibility in the results. Blandford (2013) asserts that interviews are best suited for understanding individual perceptions and experiences. Document analysis was an appropriate qualitative method of data collection in this study since it was not feasible to conduct observations due to COVID-19 pandemic protocols which did not allow face-to-face interaction with learners to conduct research. Bowen (2009, p.27) defines document analysis as "a systematic procedure for reviewing or evaluating documents—both printed and electronic (computer-based and Internet-transmitted) material". This method was utilised in addition to other methods as some convergence and corroboration was anticipated using multiple data collection and analysis methods, thereby ensuring a confluence of evidence that ensures credibility of the research (Eisner, 1991).

4.8 What is Qualitative Data?

Qualitative data is descriptive as it contains notions that cannot be quantified in numerical values as happens in quantitative research. Qualitative data may be expressed in a variety of formats such as audio- and/or video-clips, words, photographs and documents (Hiter, 2021; Pedamkar, 2020). Qualitative data is analysed using a variety of methods, some of which will be applied in this chapter. It is important to note that qualitative data cannot be objectively measured but are subjective and comprise of interpretive qualities of an item or process (Hiter, 2021). In the analysis of the qualitative data gathered by means of qualitative data collection methods, including focus group discussions, direct observations, semi-structured interviews, and document analysis, a variety of descriptors were employed to clarify the connection between the data and the tool of analysis. The collecting process is described below, and the data is presented in the following chapter.

4.8.1 The Qualitative Questionnaire

A pilot study was conducted where the questionnaire was used to obtain data from the sampled participants. A questionnaire is "a systematic compilation of questions submitted to a sampling of a population from which information is desired" (Pandey & Pandey, 2015, p.57). 120 questionnaires were prepared and administered to geography teachers at their cluster meetings. An arrangement was made with the Cluster Coordinator to allocate a time for the filling in of the questionnaire. However, some of the questionnaires were not accurately or fully completed. Hard copies of the questionnaires were collected. A qualitative questionnaire was administered to assist in selecting participants for the focus groups and to select the research site. Moreover, the DBE's *Schools Performance Reports* (2016 to 2020) assisted in the selection of the research site by analysing the schools' performances in the district for the past five years. Qualitative questionnaires were analysed, and the results presented in Chapter 6.

4.8.2 The Focus Groups

A focus group is often used as a qualitative approach to gain an in-depth understanding of social issues (Onyumba et al., 2018). In this study participants were grouped based on their expertise. Focus group research is viewed as a way of convincing people to accept new ideas before their implementation, and usually participants become cognisant of the fact that they are participating in a process intending to stimulate a change in attitude and behaviour (Breen, 2006). Prasad & Garcia (2017) attest that this method is useful where a researcher wants to obtain a deeper understanding of the phenomenon as compared to a questionnaire.

Purposive sampling was used to select participants to participate in the focus groups. Five questions or probes were predetermined for discussion around the integration of technology in the teaching of geography mapwork calculations. The interview schedule was sent to the participants prior to discussion to allow them to familiarise themselves with the issues to be discussed. Some clarifications were provided where the questions were not sufficiently understood.

The first two focus groups comprised participants who had attended minimum training while members of the third group had members who had attended the advanced training sessions organised by the Department and presented to geography teachers in the district. The focus groups schedule was used to guide the interview process and the conversation among the participants. The recordings of the sessions were transcribed, and the transcripts were used for the analysis. The sessions lasted for thirty to thirty-five minutes.

Data were solicited from a purposively selected group of participants who tended to be homogeneous in practice. The main criterion for selecting participants was the fact that they were teaching Grade 10 Geography classes at public schools. This assisted the researcher in achieving group cohesion, as the participants were homogeneous. Group cohesion is the sense of closeness and common purpose among group members (Fern, 2001). Purposive sampling in selecting focus group members was essential in this study because randomly selected "members are likely not to share a perspective on the topic and may not generate a meaningful discussion" (Morgan, 2013, p.92).

The participants did not share a wide gap in terms of social backgrounds, which could impair meaningful discussion. Moreover, variables like sex and age were not considered in the selection of the participants. A 'funnel strategy' was used to defray the notion of higher-level moderator involvement and highly standardised discussions which generally characterise structured focus groups. At the same time, non-standardised discussions with low level moderator involvement, which is typical of unstructured focus groups, were avoided. Hence, the researcher initiated the discussion with questions on the general experiences of participants and progressed to more specific problems, as suggested by Breen (2006), regarding the integration of technology into the teaching of mapwork calculations. A funnel strategy is a discussion where a non-standardised opening of the discussion is later followed by more structured and fixed questions. Careful attention was given to the transition from one flow of discussion to the next, without having to show higher level of involvement in the discussion.

Focus group interviews were conducted according to the Focus Group Guide (Appendix 7). Due to the restrictions of COVID-19 alert level 4 and time constraints, no face-to-face discussion with members of the focus groups could take place. The discussions were conducted via WhatsApp group and were captured on the audio-recorder for transcription. Data was transcribed and coded, following the coding procedures. Categories developed from the codes, later became themes. The following discussion will be based on the themes that developed from data coding.

Discussions in focus groups were moderated by the researcher. The flow of the discussion was coded to show how speakers interacted, in support or contradiction. Table 4.2 shows the coding system developed between participants in each focus group.

Table 4.2: Coding System for transitions between speakers in Focus Group Discussions

1	**Q & A**	**Between researcher and participants**	**Among participants**
2	Continuation of Topic Connections	Implicit continuation—maintains the same topic without saying so	Explicit continuation—maintains the same topic with an overt statement
3	Change in Topic (can be implicit or explicit)	Introduction of new topic—shifts the content of the discussion	Expansion—shares new aspects of existing topic
4	Differentiation—compares different aspects of topics	Agreement—reinforcing another participant's statements	Disagreement—disputing another participant's statements
5	Interpersonal Connections (not always explicit)	Support—sympathizing with another participant's statements	Lack of support-disputing another's participant's statement

4.8.3 Developing Codes from Focus Groups 1, 2 and 3

After transcriptions were completed, all the data was coded using open coding and the NVivo 12 software programme. The initial codes were created after carefully reading all the transcripts. Repeated words, sentences and paragraphs were used to create codes. Relationships were established between the codes that shared similar ideas and consequently categories were developed. In addition, a close affinity between categories was established which then minimised the number of categories from twenty-two to fourteen. The resultant number of categories ultimately became themes. The themes resulting from the process and their relationships and influences on one another are discussed below in their hierarchical importance.

After reading and re-reading the focus group transcripts, labels were created from participants' responses. Some labels involved actions, activities, and concepts while others involved opinions, processes, differences, and similarities. These labels developed into codes. From the transcript of Focus Group 1 data, fifty-nine codes were developed. However, fifteen of them were removed when categories were developed from the codes. The remaining forty-four categories were incorporated in the twenty-two themes that remained. However, the number of themes was minimised after the causal relationships were established. The influence of one theme on the other further reduced the themes, based on the newly established groupings of themes and categories. This is in line with Cope's (2010, p.282) assertion that the purposes of coding are "partly data reduction to help the researcher get a handle on large amounts of data by distilling along key themes, partly organization and partly a substantive process of data exploration, analysis and theory-building". The codes that were established from Focus Group One were added to the other codes from Focus Groups 2 and 3.

From the transcribed data from Focus Group 2, fifty-six codes were developed during indexing or coding. However, eight of these codes were dropped when categories, also known as axial codes, were developed. The remaining forty-eight codes were incorporated in the categories that developed from the coding process. Some of the codes, as in Focus Groups 1 and 3, were descriptive and analytical since they developed from open coding. Coding is an analytical practice since it involves the evaluation and organisation of data with a view to identify and understand meanings (Cope & Kurtz, 2016) of words, sentences and paragraphs in the textual data. After the relationships were established and patterns identified, categories were developed and were later reduced to fourteen when the data from all focus groups were merged to develop themes. Themes that developed are close to the data from all three focus groups. However, they are more abstract since they are more connected to the theoretical framework of the study.

From the data transcribed from Focus Group 3 discussion, fifty-five codes were developed. However, only five of these codes were dropped when categories (axial codes) were developed and the remaining fifty codes were merged with other codes from Focus Groups 1 and 2. When relationships between the codes were established and their influences on one another were identified, the number of categories was reduced to twenty-two. Further reduction of the categories occurred when other influences and relationships were established, which resulted in the development of thirteen themes described below. Evaluative and descriptive analyses of the themes will be discussed in the next chapter.

4.8.4 Themes developed from Focus Group Data

Three focus groups discussions were conducted, comprising of Grade 10 geography teachers from different secondary schools. Walden (2012) defines focus groups as the legitimate research methods to determine attitudes, experiences, perceptions and knowledge on a wide range of topics in many fields of endeavour. Bhasin (2020, p.1) adds that it is "a process of performing quality research to test any concept, idea or product". Focus groups were suitable for the study to discover the experiences of participants, their values, attitudes and reactions to the integration of technology in their pedagogic interactions with learners. This method was used as a harmonious way to gather qualitative data collectively. It was selected on the basis of its three characteristics, namely, its versatility to and compatibility with qualitative study, the opportunities offered to directly interact with participants and the distinctive advantages for data collection it offers (Vaughn, Schumm & Sinagub, 1996). It was deemed necessary to gain more knowledge by utilising this method. WhatsApp was a preferred platform to the participants. The interactions between participants in the focus groups are analysed in Table 4.2 on page 94, as a coded system for transition between them.

The main reason for using thematic data analysis is to identify patterns of meaning across datasets that provide an answer to the research questions being addressed. Also, using thematic data analysis in qualitative research involves identifying patterns through a rigorous process of data familiarisation, data coding, and theme development and revision (Hayes, 2013). Hence, this study employed thematic data analysis, not merely by counting explicit words or phrases, but to focus on identifying and describing both implicit and explicit ideas within the data (Braun & Clarke, 2006). The six-steps process as proposed by Braun &ci Clarke (2006) are simple, yet effective in conducting thematic content analysis (Majumdar, 2019). As explained in the previous chapter, the researcher addressed all the steps as prescribed by Hayes (2013) and Clarke (2006). Such prescriptions form the six phases of thematic analysis, namely:

- Familiarising oneself with the data
- Generating the initial codes
- Searching for themes
- Reviewing the themes
- Defining, refining, and naming the themes, and
- Producing the final report

Following these steps, fourteen themes were ultimately developed from the focus groups and semi-structured interviews held with the participants, The said themes are discussed below but interpretation of these themes will be concluded in the following chapter on data interpretation and discussion. These themes are merely presented here as they developed from the focus groups data through the coding process.

4.8.5 Semi-Structured Interview

After purposefully selecting the participants, they were provided with consent letters for consideration in engaging in the research study. The interview schedule was sent to the participants so that they could acquaint themselves with the issues under discussion. Discussions on the best ways of communicating and suitable times for interviews were held. Since face-to-face interviews with participants due to COVID-19 regulations were restricted, arrangements for the use of online interviews via Zoom, Skype or telephonically were arranged. Data bundles were provided to participants so that they could engage with the research activities without incurring any unnecessary expenses. All ethical protocols were verbally explained during planning sessions although they had been clearly expressed in the consent letter. Due to various reasons, both WhatsApp and telephonic conversations were used for the discussions. However, conducting the semi-structured interviews remotely was challenging as it was difficult to contextualise the participants' assertions because of the absence of visual and non-verbal clues like facial expressions, gestures, and body language, which "help to contextualise the interview in a face-to-face setting" (O'Connor et al., 2008, cited in Al Balushi, p.729).

Semi-structured interviews were conducted with two participants who teach Geography to Grade 10 classes. These two participants had completed the qualitative pilot study questionnaire that other participants from the district had completed. Blandford (2013) revealed that semi-structured interviews fall between the highly structured interviews and unstructured interviews. Structured interviews are akin to questionnaires, with pre-determined questions and close-ended questions. On the other hand, unstructured interviews are akin to a conversation with open-ended questions which have a particular focus and purpose. Semi-structured interviews have both close-ended and open-ended questions which also focus on a particular topic, and are conducted with the specific purpose of gathering data that will assist in responding to the research questions.

The semi-structured interviews used in this study comprised both close-ended and open-ended questions which allowed the researcher to proceed with follow-up questions on the topic of interest. Since qualitative semi-structured interviews (SSI) are widely used in social sciences and education studies (Bradford & Cullen, 2012), these semi-structured interviews were used to explore the participants' subjective viewpoints (Flick, 2009). Arrangements were made with the participants for interviews to take place during convenient time in order not to disrupt normal teaching at school. Such interviews were telephonic since it was not feasible to meet the individual teachers physically. The interview schedule was sent to the participants in advance so that they could familiarise themselves with the questions (See Appendix 8). Interviews were recorded using a voice-recorder and a cellular phone. The sessions were scheduled for thirty minutes. Once the interview was terminated, recordings were transcribed for data analysis. After transcription, transcripts were sent to the participant for verification and confirmation of the responses offered during the interviews. Once all the responses had been confirmed, transcripts were uploaded onto the NVivo programme and data was analysed qualitatively.

The aim of conducting semi-structured interviews was to gain an astute insight into the practices of geography teachers regarding technology integration in teaching mapwork calculations. Semi-structured interviews “allow individuals to disclose thoughts and feelings which are clearly private” (Newton, 2010, p.4). Kvale & Brinkman (2009, p.27) add that this type of interview is conducted following an interview schedule that focuses on particular themes and may include suggested questions. This study used semi-structured interviews because “they allow researchers to explore subjective viewpoints” (Flick, 2009, p.36) and assist to solicit information about people’ experiences. Lanteria (2021) describes semi-structured interviews as an interview where the interviewer or researcher asks open-ended or general questions to allow the conversation to flow freely and evolve independently. Cohen, Manion & Morrison (2007) further explain that semi-structured interviews underpin the continuum between structured and unstructured interviews.

While structured interviews are characterised with close-ended and pre-determined questions, with the interviewer following the same procedure for every respondent, unstructured interviews are the direct opposite (Lanteria, 2021). Unstructured interviews do not follow any procedure and comprise open-ended questions much like an ordinary conversation where a particular topic is discussed. While structured interviews are highly standardised and follow “a rigid procedure of asking questions in a prescribed form and order, unstructured interviews are characterised by flexibility of approach to questioning” (Kothari, 2004, p.98). Semi-structured interviews comprise pre-determined questions in the form of an interview guide but also preserve a degree of flexibility to ask follow-up questions, thereby offering an opportunity to solicit in-depth understanding from the interviewee about the phenomenon being studied. Salmons (2014, p.16) adds that “semi-structured interviews balance the pre-planned questions of a structured approach with the spontaneity and flexibility of the unstructured interview”.

4.8.6 Observations

Observation is an important data generation method in a qualitative research study. Observation is a process whereby data are gathered by observing people and events in their natural settings, and systematically recording all observable phenomena and behaviour within that natural environment (Gorman & Clayton, 2005). Observation is a systematic way of watching and listening to a phenomenon as it takes place and involves the surveillance and explanation of participant's conduct "to gather data about a wide variety of cultural backgrounds" (Ciesielska, Boström & Öhlander (2018, p.18). Kaluwich (2012, p.5) described observation as a research method in which researchers collect data using their five senses, declaring it as "a subjective method of gathering information as it depends on the researcher's sensory organs". In this study, direct observation was used to gather data from the interactions between the teachers and learners in Grade 10 classes. The manner in which teachers integrated technology in their teaching and the devices or technological tools they used was observed. It was important to conduct a direct observation to enable the researcher to observe, interact and gain a clear picture of participants in their natural environment (Mike, 2017). The data that was solicited from the classroom was analysed to confirm or contradict the data that was collected by means of semi-structured interviews. Data triangulation in this qualitative research was "significant in improving credibility and enhancing trustworthiness of the research findings" (Noble & Heale, 2019, p.67). The observational data gathered from the research site was integrated as confirmatory research, as Gray (2009) suggests.

With the easing of COVID-19 pandemic restrictions to alert level one, an opportunity presented itself to observe at least seven geography lessons on mapwork calculations in the Grade 10 classes. Most of the topics on mapwork calculations were covered as teachers were preparing for the assessments. An opportunity to observe the teachers using some devices to integrate technology in their teaching offered valuable observational data that would assist in responding to the research questions. The observational data solicited was analysed in the next chapter and the observation schedule that was used to collect the data is attached (See Appendix 8). The exemplar of the lessons that were observed is attached as Appendix 9. Below is the summary of the methods that were used to collect data from participants (See Table 4.3 on page 107).

4.8.7 Document Analysis

Document analysis is a form of qualitative research that uses a systematic procedure for reviewing, analysing, or evaluating documentary evidence—both printed and electronic (computer-based and Internet-transmitted) material to respond to specific research questions (Bowen, 2017; Frey, 2018). As a way of gathering information to formally describe a text, Taber (2007) notes that document analysis involves identifying the content of some documents and naming their components with the purpose of analysing them to respond to the research questions. In this research, the following documents were analysed:

i) The Geography Annual Teaching Plan
ii) The daily preparation books or actual lesson plans
iii) Learners' written activities on mapwork calculations
iv) Online worksheets/activities on mapwork calculations
v) Teachers' notes on mapwork calculations
vi) Grade 10 Mark lists of tests and the examination marks for 2021

These documents were relevant in identifying the year programme that teachers are expected to cover, and the time allocated for the teaching of mapwork calculations at Grade 10 level. The kind of lesson plans teachers create in preparation for the teaching of a particular aspect in mapwork calculations was vital to the analysis. The notes that teachers provide to their learners were important for the analysis to determine whether they are clear and comprehensible to the learners, but most importantly, whether they relate to the integration of technology in teaching mapwork calculations. Learners' activities were also important to determine the extent to which teachers integrate technology in some way. The mark lists were analysed to determine the level of learners' performance in comparison to being taught through technology-integrated pedagogy. Teachers' lesson preparations, learners' written activities and geography notes on mapwork calculations were considered to assist in verifying some responses that teachers gave during the semi-structured interviews.

Document analysis was conducted at the research site school that obtained the highest percentage in Matric results for the past five consecutive years in the district. The main objective was to solicit primary and secondary data at the purposively selected research site. The choice of the school was solely based on learner performance. It was of significance to discover how the teachers maintained high performance despite being a public school and located in the township. Document analysis as a data generation method would serve to describe the prevailing practices in the research site, to discover the relative importance of, or interest in (Best & Kahn, 2006) t4he use of educational technology in the classroom. The research site was selected based on its optimal and consistent learner performance. The criteria followed in selecting the research site included the requirement that the school falls within the category of public schools in the district but must discount quintile ranking. The school had a large student population doing Geography at Matric level. It was situated in the township and surrounded by a profusion of informal settlements, yet the school has consistently achieved a 100% pass rate in Geography, as well as in other subjects for the last five consecutive years. A large number of learners who attend the school were from middle to low-economic status families.

While there are other schools within the district that have managed to achieve a 100% pass rate in the past three years, they have fewer learners who registered to write their Matric examinations. This implies that it is feasible and manageable to pay individual attention to each learner in these schools, and most of them are former Model C schools with considerable resources at their disposal. It is presumed that they have an opportunity to use ICTs in their teaching and learning because even the student population is largely comprised of learners from middle to upper-middle class residents. Unlike the selected research site, most of the learners come from the local informal settlements and township dwellers who can barely afford to pay the school fees, let alone the digital devices and internet connection that are expected to facilitate effective teaching and learning. Through the study, the researcher attempted to reach an understanding of how the teachers in the sampled school managed to thrive against all odds if they were not integrating technology in their teaching activities.

The researcher attempted to discover the extent of the integration of ICTs at the school, and whether this factor had contributed to the attainment of these consistently excellent results. The documents reviewed included, *inter alia*, the Annual Teaching Plan (ATP), the teachers' seven lesson plans, teaching notes, learners' online worksheets, workbooks and materials used to facilitate class activities, assessment activities and related records. These documents provided different qualitative data sets that assisted to generate themes for analysis.

4.9 Techniques used in Data Analysis

Once data have been coded, the process of analysis begins. Data analysis is the process where data are collected and organised, bringing order, structure and meaning to them (Grant, 2020;

Marshall & Rossman, 1999), so that a researcher can derive assistive information from the slew or mass of collected data. Dudovskly (2022) describes data analysis as the process in which raw data is cleaned, changed and processed, thereby extracting actionable and relevant information that assists to make informed decisions. Data analysis and interpretation require the use of deductive and inductive logic in the research to arrive at logical conclusions (Best & Kahn, 2006; Pedamkar, 2020). The process of cleaning, changing and processing raw data involves many steps that must be followed to enable credible data analysis and trustworthy findings in qualitative research. This process requires the following steps to be made to arrive at the conclusion responding to the research questions (Hillier, 2021):

• Defining the research question

• Collecting data

• Cleaning the data

• Analysing the data

•Sharing the results, and

•Embracing the errors

The method used to analyse data was the Thematic Content Analysis (TCA). Thematic analysis is a method for systematically identifying, organising, and offering insight into patterns of meaning (themes) across a data set (Braun & Clarke, 2006). Best & Kahn (2006) assert that the analysis has to do with explaining the status of a phenomenon at a specific time or the development of the phenomenon over a long time. In this study the phenomenon of technology integration in the teaching of Geography mapwork calculations was explored in Grade 10 classes as it is believed that learners should develop a sound grounding of mapwork calculations from the initial stages of the FET phase before they attempt the Matric examination. Caution was taken with respect to the language that participants used, that is, how they expressed their views and experiences about the integration of technology in their practices. Their views on the use of technological tools and the school arrangements (integration plan) regarding the use of technology were considered in line with the verbalised gestures they displayed when expressing their perceptions. The teachers' responses allowed for a selection of appropriate themes which was categorised. Recurring themes were categorised, and assisted in developing an analysis of data. Braun & Clarke's (2006) stages of developing thematic codes were used for analysis.

Data were perused repeatedly. While reading, initial codes were generated by highlighting all the repeating words in the transcripts. When searching for the themes, a list of all repeating words was highlighted. The themes were then reviewed by underlining any repetitive concept or idea. In defining and naming the themes, a list of repeating concepts was studied and one theme was chosen. In determining how the themes related to one another, the 'why' and 'how' of each research question was addressed.

The NVivo software programme was used to process the issue of thematic analysis. This software programme is suitable for the processing of qualitative data, from electronic data visualisation, storing and coding, data inking and mapping, to thematising and reporting. This qualitative data analysis software programme saved time as it could analyse large volumes of complex data, thereby producing credible and trustworthy research results. Using the NVivo programme allowed for the processing of different data sets. NVivo is the programme suggested for use by universities with a valid licence.

Data were generated using data production methods that allow the researcher to develop insight and understanding into the research phenomenon. As the researcher analysed the data using various techniques of data analysis, an attempt was made to describe all the different sets of data, which are discussed in their different formats in the following chapter. Finally, the researcher acknowledges the oversights which may have occurred in the data collection and analysis procedures in this research.

4.10 Evaluation and Justification of Methodological Choices

The methods of data production and analysis selected are effective for data generation in relation to this type of inquiry. The use of case study is consistent with other studies of the same expertise where in-depth and rich descriptions of a phenomenon are required. Adams (2018) asserts that semi-structured interviews (SSI) are ably suited to "ask probing, open-ended questions and want to know the independent thoughts of each individual in a group". Semi-structured interviews are undoubtedly suitable for this study as it focused on the need to understand how teachers integrate technology in their teaching of geography mapwork, and to know what technology tools they use in their interaction with learners. Teachers were also requested to complete the qualitative questionnaire to gain a better understanding of their technological knowledge (TK), the extent of their content knowledge (CK) on mapwork calculations and how they teach (PK) the themes pertaining to mapwork. The flexibility and versatility of semi-structured interview renders it even more suitable for this study, making this tool a popular choice for collecting qualitative data (Kallio, et al., 2016). Using the interview schedule, the participants were guided to respond to the core questions and follow-up where clarity was needed. Furthermore, document analysis would provide evidence in relation to the preparation of lessons and how teachers plan to integrate technology on paper, while observations would confirm the execution of what teachers had planned through actual classroom practice.

4.11 Why the Methods suit the Objectives

The methods employed suited the objectives that the study sought to achieve. The objectives of the research are:

To explore how teachers use technology to teach mapwork calculations in Grade 10 Geography education.

To discover the reasons why teachers use the methods they do in the teaching of mapwork calculations.

To explore the implications of integrating technology in the teaching and learning of Geography in South African secondary schools.

All five qualitative methods of data generation yielded in-depth qualitative data that brought about an understanding of the extent to which teachers use technology or ICT tools in their classes. The methods used include qualitative questionnaires, focus groups, semi-structured interviews, observations and document analysis. These methods provided insight into the implications of teachers using technology, that is, how they viewed technology integration in their pedagogic practices. Focus group discussions helped in providing insight into what teachers think concerning the integration of technology in class. Semi-structured interviews with Grade 10 geography teachers resulted in an in-depth insight into their lesson planning and provisioning in their respective schools, and how they overcome the shortage of resources. Document analysis gave testimony to the use of technology from planning to execution of the lesson plans in class, including the online activities and assessments that teachers gave to their learners.

The methodology used in this study contributed to a new understanding of the reality in secondary schools within the district and the experiences of geography teachers in the research site. The extent of the integration of technological tools in the teaching of geography mapwork calculations is presented in Chapter 6.

4.12 Methodological Limitations to the Study

Price and Marman (2004, p.168) define limitations to the research study as "those characteristics of design or methodology that impacted or influenced the interpretation of the findings from the research". Theofanidis & Fountouki (2019, p.156) further describe limitations as "potential weaknesses that are usually out of the researcher's control and are closely associated with the chosen research design, statistical model constraints, funding constraints or other factors". In this case study, the design does not allow the findings to be generalised to all secondary schools in the province or district. In addition, it was not possible to reach all sampled schools in the district due to the restrictions imposed by the Government in relation to the COVID-19 pandemic protocols. This prolonged the time for data production. Moreover, it was not always possible to access all the participants at the same time for the focus group discussion. This limited the number of participants to four in one focus group, which is nevertheless, recommended for homogenous focus group (Breen, 2006).

Furthermore, most of the teachers do not have computers to facilitate online communication via Zoom or Skype platforms, and some teachers had never used these platforms. Consequently, the researcher could not observe the participants' physical gestures when they expressed their views on matters of concern. The researcher only verbalised their assertions through voice tones. Finally, the WhatsApp platform was used, which they were familiar with.

Some of the questionnaires used for piloting were never returned. Initially, direct observations in the classrooms could not be conducted due to high level COVID-19 restrictions. However, when the alert levels were reduced to the minimum, the researcher was permitted to conduct observations, albeit with strict observance of the pandemic protocols. Alternative methods were used to solicit data about the research site. The WhatsApp platform had been used in other studies (Shambare, 2014; Barhoumi, 2015; Ngalomba, 2020; Bonsu et al., (2021), and was ultimately employed in this study.

4.13 Rigour in the Use of Data Collection Methods

To ensure that established procedures and practices in generating data were followed, the researcher visited schools that had been purposively selected, and submitted letters of request to the principals to allow for interaction with their teachers. Procedures were discussed with the participants regarding focus group discussions.

Table 4.3: The summary of Data production

METHODS	PARTICIPANTS	PROCESS	DATA PRODUCTION
Questionnaire	Grade 10 geography teachers in the district	Providing questionnaires to sampled participants	Retrieval of questionnaires
Focus Groups (FGs)	Three Focus Groups	3 Focus Group discussions with Grade 10 teachers from schools. Teachers were selected on the bases of their expertise in technology integration in teaching geography map work	FG 1: Six participants FG 2: Four Participants FG 3: Five Participants ***Points of discussion***: •experiences of teachers in teaching map work calculations •competences in integrating technology in the classroom •Influences of technology on lesson planning •influence of technology on learner participation in class •influence of technology on learner pass rate •professional support to teachers in technology integration
Semi-structured interviews (SSIs)	Two Grade 10 teachers from the research site	Two interview sessions with Grade 10 teachers	***Interview Schedule was used:*** •Teachers' understanding of technology integration •The resources that teachers use in their classrooms •Challenges experienced by teachers in integrating technology in the classrooms •Teachers' ideas on best practices in technology integration
Classroom Observations	Grade 10 Teachers and learners	Observed seven lessons on mapwork calculations	***Observation Schedule was used:*** •Classroom environment •Lesson observations in class •Strategies used during lesson presentation •How technology is integrated •Resources used
Document analysis	Teachers' documents	Analysis of teachers' official files/records and learners' projects	•ATP • Six lesson plans •Teacher's teaching notes •Mark lists/schedule •Learners' online worksheets •Class projects on mapwork

4.14 The Research Site

The research study is located within the Umlazi district where the research site was selected based on the excellent performance of Grade 12 geography learners in five consecutive years. The research site is where most of the research activities took place in terms of data generation. The research site was selected based on specific criteria as specified in the previous chapter. The school was assigned a pseudonym, Night Owl Secondary School, to maintain privacy and confidentiality as the code of ethics dictate.

4.14.1 Site Description

The research site is Night Owl Secondary School (pseudonym), which was used as the research site for this study. The school is in the previously disadvantaged township for the indigenous African majority. It is surrounded by low-cost four-roomed houses and a great number of informal settlements from which most of the learners in the school come. The school is poorly fenced with a security-guard at the gate but has the basic infrastructure such as running water and electricity. Most classrooms are approximately $10m^2$. The school is located next to a health clinic and a sportsground along the main road.

4.14.2 Structural Composition

Currently, it has a student population of approximately 1 300 learners, of whom 63% are female and the rest are male. The school has approximately 40 members of staff, including the principal, two deputies and five Heads of Departments. The total enrolment of the school does not significantly fluctuate from year to year. Grades 8 to 12 are alphabetically structured from A to D. The school comprises five separate departments, namely, Languages, Humanities, Commerce, Science and Mathematics. Teachers are distributed according to their lines of specialisation. A group of subjects are managed by one Head of Department who leads that department. The distribution of subjects among the departments in a school is unique to a particular school, depending on the subjects offered by that school. Table 4.4 below shows the distribution of subjects in the departments at the Night Owl Secondary School.

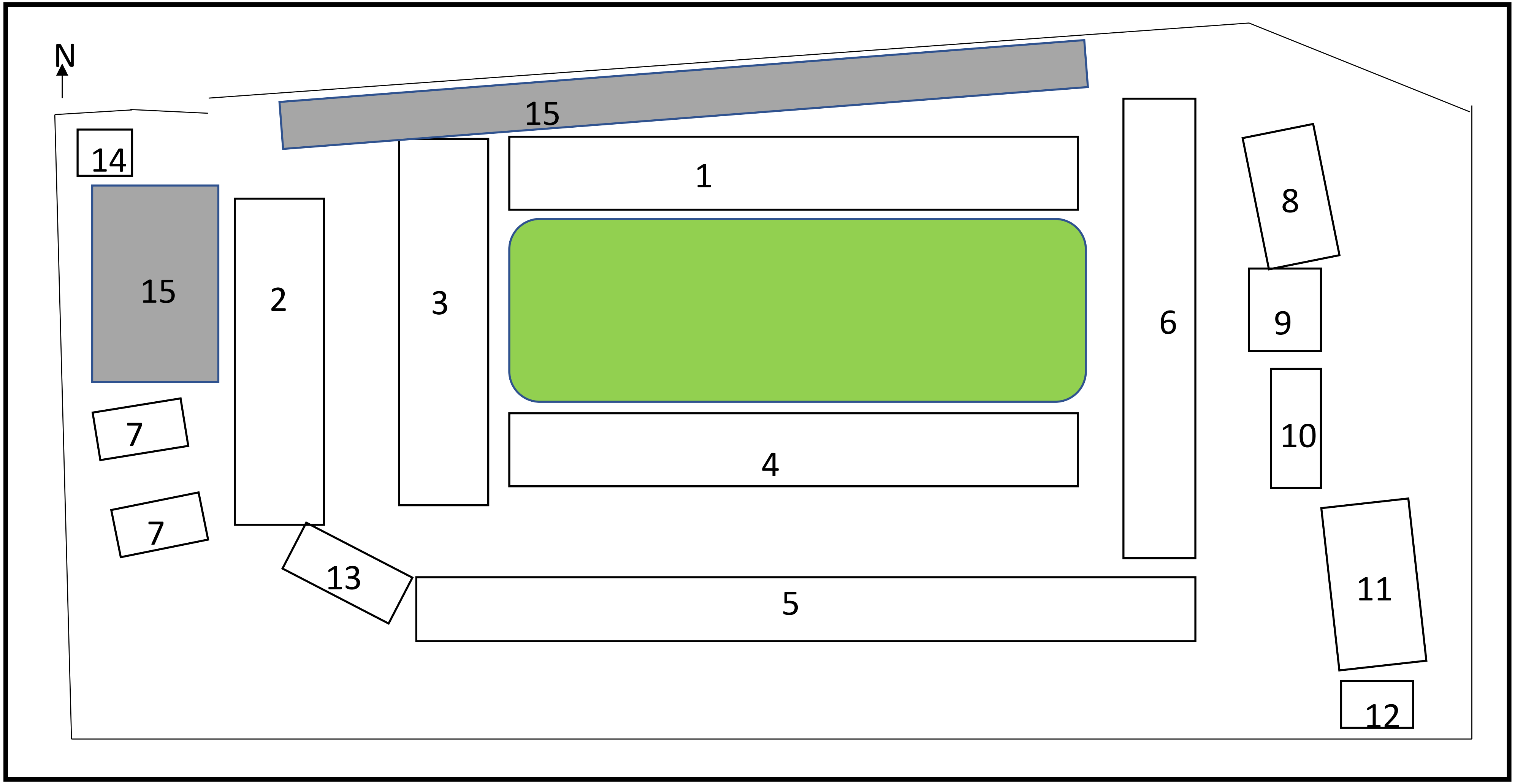


Figure 4.1: *Sketch of the Night Owl Secondary School research site*

MAP LEGEND

1.Grade 11 (2 classrooms) and 12 classrooms (2 classrooms)	9. Toilets for the physically challenged
2. Administration block	10. Kitchen
3. Grade 12 (2 classrooms) and HOD offices	11. Computer laboratory
4. Grade 9 (4 classrooms)	12. Cottages
5. Grade 8 (4 classrooms) and Grade 10 classrooms	13. Grade 10 classroom
6. Laboratories (Biology and Physical Science)	14. Security guard room
7. Grades 11 and 12 classrooms	15. Parking bays
8. Media Centre	

The school has a fully equipped library, a Physical Science laboratory where Science experiments are conducted, and where most of the chemical compounds are kept. Adjacent to the Physical Science laboratory is the Natural Sciences laboratory where specimens of plants and animals are housed. The school prides itself with a Media Centre where Speech and Drama is taught, as well as a large, air-conditioned Computer room where Computer Applications Technology (CAT) is taught. Five permanently employed non-teaching staff members take care of the premises. The School Secretary's office lies adjacent to the principal's office and has sufficient space to store all the stationery and consumables. The printing-room is located next to the Deputy Principal's office. The kitchen with a lockable storeroom is located behind the classrooms.

Table 4.4: Departments that manage subjects at the Night Owl Secondary School

DEPARTMENTS	**LANGUAGES**	**HUMANITIES**	**COMMERCE**	**SCIENCE**	**MATHEMATICS**
SUBJECTS	•IsiZulu •English	•Social Sciences •Geography •History •Life Orientation •Arts	•Accounting •Economics •Business Studies	•Life Sciences •Physics •Technology •Natural Sciences	•Pure Maths •Mathematical Literacy

The average class enrolment in Grades 8 to 10 is seventy. It decreases to sixty-five and forty-six in Grades 11 and 12, respectively. All learners in the last two classes in each Grade, i.e., C and D, are taking Geography in the Humanities Department, while in other classes are distributed across other Departments in the school.

The distribution of learners and class teacher is reflected in Table 4.5 below:

Table 4.5: Distribution of learners across Grades at the Night Owl Secondary School for 2021

ROOM NO.	GRADE	CLASS	TOTAL LEARNERS	MALE	FEMALE	EDUCATOR
	Grade 8		***276***	***103***	***173***	
1		8A	71	27	44	Teacher A
2		8B	69	24	45	Teacher B
3		8C	67	27	40	Teacher C
4		8D	69	25	44	Teacher D
	Grade 9		***278***	***95***	***183***	
5		9A	69	24	45	Teacher E
6		9B	73	26	47	Teacher F
7		9C	66	20	46	Teacher G
8		9D	70	25	45	Teacher H
	Grade 10		***284***	***105***	***179***	
9		10A	61	23	38	Teacher J
10		10B	76	25	51	Teacher K
11		10C	75	29	46	Teacher L
12		10D	72	28	44	Teacher M
	Grade 11		***261***	***111***	***150***	
13		11A	61	23	38	Teacher N
14		11B	67	27	40	Teacher P
15		11C	57	26	31	Teacher Q
16		11D	76	35	41	Teacher R
	Grade 12		***185***	***62***	***123***	
17		12A	55	20	35	Teacher S
18		12B	44	15	29	Teacher T
19		12C	39	16	23	Teacher U
20		12D	47	11	36	Teacher V
TOTAL NUMBER OF LEARNERS IN THE SCHOOL			***1 284***	***476***	***808***	

4.14.3 Admissions and Notional Time

The school admits learners only to do Grade 8. No new learners are admitted in any other Grade. The reason for this is to inculcate the rules and culture of the school from an early age, as one participant responded during the interview. The school officially opens at 6:50am and closes at 4:00pm. However, special arrangements are made with parents and learners regarding the study periods, which can be accommodated earlier or later in the day. Study periods last up to 17:00 in Winter and 18:00 in Summer. Some teachers use weekends to teach critical subjects to learners from other schools as well. During the weekends, classes commence at 7:00am and end at 13:00pm.

4.14.4 Management of Resources

Night Owl Secondary School has a written policy on the management of physical resources of the school. All learners and parents know the policies and regulations pertaining to resource management, as they are given copies of textbooks each year. For example, all learners are expected to bring in reams of photocopying paper at the beginning of the year. The school only seeks donations to cover the expenses of ink-cartridges, since it is a quintile 3 no-fee school. Lost or torn textbooks must be replaced or replenished by learners as these books are issued at the beginning of the year on loan. Each Head of Department (HoD) is responsible for the materials under the jurisdiction of the respective department. This policy helps to keep the textbooks intact and in the same number as losses are replaced with new books.

4.15 Reflexivity and Positionality

Reflexivity is the process whereby a researcher questions him or herself about the influence s/he may have in the research process, that is, how the personal history is likely to influence the choice of the research topic, how the sexual orientation of the researcher, culture and professional background are likely to influence positioning in the research topic and relations with participants, and so forth. Dowling (2006) describes reflexivity as the process of self-critique whereby the researcher considers how his or her personal experiences might or might not have affected and influenced the research process. Haynes (2012, p.1) defines reflexivity as “an awareness of the researcher’s role in the practice of research and the way this is influenced by the object of the research, enabling the researcher to acknowledge the way in which he or she affects both the research processes and outcomes”. In reflexivity, the researcher analyses his or her conditions and position in relation to the research or participants (Patnaik, 2013, p.2). Reflexivity is about scrutinising your own practices, judgments and beliefs during the data generation process, thereby shifting the focus from the research to the researcher.

Haynes (2012, p.20) further elucidates that reflexivity "involves thinking about how we generate our thinking, constantly revising the pre-existing understanding of a phenomenon while considering the new understanding, and how the research is affected by these understandings".

Reflexivity has several benefits for qualitative researchers. Delve & Limpaecher (2022b) assert that reflexivity holds researchers accountable while improving the perceptions of the public. The audience is taken into confidence about the steps conducted to arrive at the findings of the study. This means that researchers who are honest and open about their background, belief systems and underlying bias can connect with their reader much better than those who are not. Delve & Limpaecher (2022b) further indicates that researchers who incorporate reflexivity in their research studies can present the results with clarity and precision. Therefore, true reflexivity compels the researcher to engage in authentic introspection regarding what might affect their research work.

4.15.1 Personal Reflexivity in the Research

I have taught Geography to learners in the Senior and Further Education and Training (FET) phases for the past twenty years, and was deployed in a township secondary school located in a middle to lower class community. I experienced many challenges concerning the provision of resources as the school received a meagre financial allocation despite the learner population being close to a thousand. The school could not afford to purchase all the necessary teacher requirements to teach different subjects. This made it difficult to achieve the learning outcomes as specified in the CAPS documents. Nonetheless, we tried our best as teachers to share and assist one another where possible. The area I found more challenging was the geography mapwork. It was particularly challenging because the school did not have sufficient maps, let alone a geography laboratory or resource centre. In addition, the policies did not allow learners to bring mobile phones to school, otherwise, they were confiscated until the end of the year. This situation motivated me to select the research topic, focusing on the integration of technology in the teaching of Geography. I was convinced that with technology, we could improve on the teaching of this subject. I believed that we could follow what other countries had done to raise their learner performance, by allowing them to bring their own devices like tablets and cell phones to school for learning purposes. The Bring Your Own Device (BYOD) policy, as it is called, transformed my view regarding the use of technology in teaching. The school governing bodies (SGBs) did not have policies that permitted the use of mobile phones on school premises.

My gender as a variable to determine reflexivity or positionality did not influence data collection, while culture had little effect, if any. Most of the teachers believed in the development of the subject as much as I did. Cultural differences among teachers had no role in determining the direction the development would take if it would benefit the learners. My professional background as a cluster leader played a positive role, as teachers believed that I knew what was expected of them in their practice. However, it did not distract my interview sessions as many of the participants knew that I endorsed their practices, working under the difficult circumstances as they did.

4.15.2 Personal Position in the Research

Positionality is determined by where one stands in relation to the other. Since we are members of cultural communities, we all hold certain positions in these communities, where, as Banks argues, the interpretations of our life experiences are "mediated by the interaction of a complex set of status variables such as gender, social class, age, political affiliation, religion and region" (Banks, 1998, p.8). The positions that we hold in terms of some of these variables lead us where we interpret reality from different positions, which could be termed paradigms. Merriam et al., (2001) warn that this position can shift in communities, and specify four positions from which researchers can interpret reality in different cultural communities, namely, indigenous-insider, indigenous-outsider, external-insider, and external-outsider. The first position (indigenous-insider) is attributed to one who endorses the unique values, perspectives, behaviours, beliefs, and knowledge of one's indigenous community. On the other hand, an indigenous-outsider possesses a high level of cultural assimilation of an outsider or opposition group but remains connected to one's indigenous community. In the third position, that of an external-insider, one rejects much of one's community and endorses those of another community to become an 'adopted insider' while the external-outsider is socialised into a community different from the one in which one is doing research. Banks's (1998) analysis of positionality enabled me to view my position in relation to the participants and the wider community of geography teachers within the specified district.

In this research endeavour, I assumed the position of the indigenous-insider in the sense that I had been a geography teacher in the same district where the study was conducted. I knew most of the teachers and their respective schools. I endorsed most of the values held by the participants as I had been part of the community for over two decades. As positions shift, I later became an indigenous-outsider having strong cultural assimilation to the research community while remaining connected to my indigenous community of geography teachers within the district. The first position, being an indigenous-insider minimised the power relations between myself as the researcher and the participants, as they viewed me as one of their own. The consent letters also alleviated the unequal power relations with the participants as I made it clear that the research study was solely meant for academic achievement and their status of anonymity would remain vital in all our engagements.

My personal history and professional competence had possible advantages in that most of geography teachers knew the progress I had made as a cluster leader, trying to advance the teaching of the subject. When I conducted focus group interviews with some participants, some had the expectation that I would be able to influence the District's Coordinator to turn matters around and make provision for a change of policy and resource provisions in terms of connectivity in their schools. That, somehow, could have been a barrier, as I made it explicit that the study was not intended for a change of policy, but to create an understanding about the way teachers integrate technology in their teaching of geography mapwork, and possibly how they could view the phenomenon of technology integration in the subject.

4.16 Ethical Considerations

Ethical issues in research should be considered as they relate to the research participants, researchers, and research sites. They involve collecting data from participants; seeking consent; providing incentives where applicable; seeking sensitive information; the possibility of causing harm to participants; and maintaining confidentiality (Kumar, 2011; Kothari, 2004; Creswell & Poth, 2018). Ethical issues involve considering what is ethical for the study to be acceptable to everybody concerned, especially the relevant academic communities. Ethical considerations incorporate ethical principles like the right to self-determination, anonymity, confidentiality, and informed consent as they often shape what is possible in terms of how data can be gathered and results reported (Blandford, 2013). This research abides by the code of ethics as determined by the Human Social Sciences Research Ethics Committee (HSSREC).

In qualitative studies, validity refers to the appropriateness of the inferences made about the results of an assessment (Messack, 1989; Kothari, 2004). Simply put, it refers to the degree to which empirical evidence and theoretical rationales support the adequacy and appropriateness of interpretations and actions based on test scores. However, Cho & Trent (2006) point out that the conception of validity that is appropriate, is dependent upon the inquiry paradigms being engaged. Reliability refers to the degree of consistency with which an instrument measures the attribute it is designed to measure (Polit & Hungler, 1993; Creswell, 2009; Kumar, 2011; Guba & Lincoln, 2018), reflecting consistency and replicability over time.

In qualitative studies, ethical issues revolve around the trustworthiness of the study. Gunawan (2015) asserts that a study is trustworthy only if the reader of the research report judges it to be so. Trustworthiness is divided into credibility, which corresponds with the positivist concept of internal validity, dependability, which relates to reliability in quantitative studies, transferability, which is a form of external validity in quantitative studies, as well as confirmability which relates to the issues of presentation (Guba & Lincoln, 2018; Denzin & Lincoln, 2000). Elo, et al., (2014) conclude that the trustworthiness of content analysis results depends on the availability of rich, appropriate, and well-saturated data. Therefore, data collection, analysis and result reporting go hand in hand in qualitative research.

Furthermore, credibility evaluates whether there is a link between the author's interpretation and the original source, whereas dependability can be established if the research process is logical, traceable, and clearly documented (Munn, et al., 2014; Elo, et al., 2014). Transferability is "the degree to which the results of qualitative research can be transferred to other contexts or settings with other respondents", as defined by Korstjens & Moser (2018, p.2). The researcher facilitates the transferability judgment by a potential user through rich description (Guba & Lincoln, 2018; Korstjens & Moser, 2018). Furthermore, transferability can be achieved through rich description which implies describing not just the behaviour and experiences, but their contexts as well, so that the behaviour and experiences become meaningful to an outsider. Confirmability is the degree to which the findings of the study could be confirmed by other researchers (Guba & Lincoln, 2018; Lincoln & Guba, 1985). Confirmability is concerned with establishing that data and interpretations of the findings are not figments of the investigators' imagination, but clearly derived from the data. Trustworthiness in this research was established following the above-named tenets of qualitative inquiry.

The research took place in a school environment where semi-structured interviews and document analysis was conducted. Other methods of data generation were applied remotely via the WhatsApp platform or telephonic conversations. There was no captive audience involved in the research. A captive audience implies that participants have an obligation to participate in the study because of the authority or power of the researcher in relation to the participants. The Merriam-Webster Dictionary defines a captive audience as “a person or people who are unable to leave a specific place and therefore are forced to pay attention to what is being said”. In other words, participation was purely voluntary. To avoid bias and to promote voluntary participation, no incentives were used. Participants were asked to consider the questions in the focus group and interview schedules to ensure they had correctly construed the questions asked. For questions that needed clarification or rephrasing, the researcher attended to all the discrepancies by rephrasing, or clarifying the identified questions.

Teachers in the focus groups as well as those in the research site, were provided with informed consent letters which they had to sign to give consent for taking part in the study. I verbally emphasised participants’ anonymity over what was written in their consent letters. The meaning and implications of the consent/assent letter was further explained.

Recommendations were discussed with participants in the focus groups and the research site. An electronic copy of the thesis will be given to each participant for verification. Participants were informed that a hard copy of the thesis will also be available at the library at the University of KwaZulu-Natal (UKZN).

4.16.1 Credibility

According to Patnaik (2013, p.7), “credibility refers to the vividness and accuracy of description of the phenomenon under study”. Korstjens & Moser (2018, p.2) defines credibility as the “confidence that can be placed in the truth of the research findings”. In addressing credibility in this research study, I increased the level of credibility of the findings as they represent plausible information that was drawn from the participants’ original data and the interpretations are as close to the data as possible. Established and prolific researchers concur that credibility must be understood as the focus of trustworthiness of the data and data analysis (Guba & Lincoln, 1985). Since credibility is believed to be the first criterion in establishing trustworthiness of the study, it requires the researcher to form a clear link between the findings and the reality, to demonstrate the truthfulness of the entire process. Credibility could not be established by prolonged engagement in the research site due to the rampant COVID-19 pandemic. Alternatively, ongoing observation was feasible. This is the process of identifying the most relevant characteristics and elements pertaining to the study on which the researcher intends to focus in detail (Korstjens & Moser, 2018). Credibility is said to be existent if the results mirror the perspectives and opinions of the participants in the study, that is, the level of confidence the researcher has about the methods used in the research for data collection and analysis, as well as the findings reached after the data interpretation.

4.16.2 Transferability

Transferability is the extent to which a qualitative researcher can demonstrate that the research findings are applicable to other contexts. Korstjens and Moser (2018, p.2) define this criterion as "the degree to which the results of qualitative research can be transferred to other contexts or settings with other respondents". This is where a researcher demonstrate that the findings of the study are applicable to other contexts if the same methods and procedures are employed. The researcher facilitates the transferability judgment by a potential user through rich description (Korstjens & Moser, 2018). Transferability adds rigour to the level of trustworthiness and credibility that Morse, Barrett, Mayan, Olson, & Spiers, (2008) argue for. However, it is not always possible to demonstrate that the findings and final conclusions in qualitative studies are transferable to other situations and participants, since the project is specific to a limited number of persons in a specific environment where various external factors contribute to the current *status quo*. Nonetheless, similar results may be achieved in similar situations if the same research design is used to explore the same phenomenon. Patnaik (2013, p.7) argues that "transferability is the equivalent of external validity, that is, how well were the data likely to fit into a context different from the one in which they were generated". This study can, indeed, yield similar results if it could be transferred to similar situations and similar procedure be executed to similar population in similar geographic circumstances.

4.16.3 Dependability

Patnaik (2013, p.7) asserts that dependability is the extent to which the data demonstrates the phenomenon it is expected to demonstrate. Dependability is related to reliability in quantitative research as suggested by Guba & Lincoln (1985). It occurs when another researcher follows the trails of the former researcher and achieve the same results. This could be achieved by describing the purpose of the study, explaining the selection of the participants, how data were collected and reduced for the purpose of analysis, discussing the interpretation and presentation of the findings, and explaining the methods that the researcher used to determine the credibility of the data. To establish the dependability in this study, the researcher provided a detailed description of the research methods in Chapter 4 and conducted a step-by-step repetition in studying the codes and themes to identify similarities. The researcher also studied the findings repeatedly to enhance the dependability of the results. However, as Kumar (2011) suggests, it may not be easy to establish a required level of dependability since qualitative research advocates flexibility and freedom. Hence, the researcher kept detailed records of the process for other researchers who may want to replicate the study to ascertain the level of dependability of this study. Providing details and keeping all the records would enable the reader of the research report to gain an understanding of the methods used in the study and to determine their effectiveness in producing the ultimate results that are dependable. The researcher constantly conferred with participants from transcription to the interpretation of the findings. This is consistent with Korstjens & Moser's (2018, p.2) view that dependability must involve the participants' assessment whether the finding, interpretations and recommendations are supported by the data solicited from them during data collection stages.

4.16.4 Confirmability

Patnaik (2013) argues that confirmability is essentially a confirmation that the previous three conditions of trustworthiness have been addressed. Confirmability is akin to reliability in quantitative studies, and it "refers to the degree to which the results could be confirmed or corroborated by others" (Guba & Lincoln, 2007 p.149). The reflective nature of qualitative research requires the researcher to maintain a sense of awareness and openness to the entire study and the results thereof. Korstjens & Moser (2018, p.2) define confirmability as "the degree to which the findings of the research study could be confirmed by other researchers". Confirmability adds rigour to the study. To ascertain that confirmability is guaranteed, Bowen (2006) proposes three strategies that can be used to guard against the use of the researcher's imagination in the study. These strategies involve conducting an audit trial, reflexive journal, and triangulation. These strategies affirm the confirmability of the study. The audit trial is used to ensure that the entire research process and product of the research do not originate from the researcher's imagination, but reflect a true and valid process that the research passed through all the stages (Bowen, 2009). The reflexive journal is a technique to describe the experiences that the researcher went through from own perspective, including reactions to particular situations and ideas about data collection and the interpretive framework of the study (Barry &

O'Callaghan (2008); Lincoln & Guba (1982); Tribe, Xiao & Chambers (2012). Triangulation is defined by Heale & Forbes (2013, p.3); Patton, 1999) as the "use of multiple methods or data sources in qualitative research to develop a comprehensive understanding of phenomena". To establish confirmability in this research, the qualitative data collection methods were triangulated, which involved focus group discussions, semi-structured interviews, observations and document analysis. The journal containing data records was kept in both electronic and physical format.

4.17 Conclusion

This chapter described the methodology of this study with the aim of creating an understanding regarding all the methods of data collection used by the researcher. The researcher described the methods for the selection of participants for each method through the process of applying the method and the use of collected data to analyse the phenomenon under study. The chapter creates an awareness of the code of ethics that was followed to ensure that all the participants were not jeopardised by their participation in the study.

CHAPTER 5

REFLECTING ON DATA GENERATION, PRESENTATION AND ANALYSIS

5.1 Orientation to the chapter

This chapter presents data that was collected from participants using qualitative methods of data collection. Data presentation is the use of various graphical formats to visually present data collected from different sources of information. This is mainly done to represent the relationships that exist between two or more data sets to enable the reader to make an informed decision based on the available data. In this research study, data is presented in textual, graphic, and tabular form. Different data sets are presented in different formats, depending on the type of data that was collected, as well as the instrument used to collect them. However, no analysis of any data is presented in this chapter but will be presented in the next chapter. The data presented here was collected using qualitative methods such as the qualitative questionnaire, focus groups, semi-structured interviews, document analysis and observations. All five data sets emerging from the collected data will be analysed in Chapter 6.

5. 2 Findings from the Qualitative Questionnaire

The qualitative questionnaire is a research instrument that does not restrict participants to close-ended questions such as tick boxes, but enables participants to reply to open-ended questions in detail (SAGE, 2015). Participants use their own words to describe, explain or define the phenomenon that the researcher seeks answers to. The questionnaire in this study included both closed- and open-ended questions. The distribution of the questionnaire to the sampled geography teachers followed standard procedure. Table 5.1 shows the distribution of the questionnaire and the calculations used to find the sample that accurately represented the population under study.

A questionnaire was used to solicit data from the Grade 10 geography teachers in the Umlazi district and was administered to teachers who had attended a moderation session at two teachers' centres. At the time of the data collection, the district did not have a Subject Coordinator but only a volunteer teacher who represented the coordinator. The post of the Subject Advisor had not been filled for the past twelve years. The teachers willingly cooperated with the Subject Coordinator to make significant strides in advancing the objectives of the CAPS Geography subject and attaining the desired subject learning outcomes as envisaged by the DBE. The Subject Coordinator assisted by providing opportunity and means to administer the questionnaire to the teachers during moderation at the two Teachers' Centres. Other questionnaires were sent to schools as hard copies. No participants responded to emailed questionnaires.

Five themes were set up to categorise data in terms of:

*Personal history in relation to the subject;

*School context as it relates to the use of technology to enhance the teaching of Mapwork;

*Personal experiences with regard to the use of technology in teaching and learning;

* Class management in relation to the use of technology;

*The implications of technology in relation to the teachers' classroom practice.

Out of 120 sampled schools in the district, which has 173 secondary schools, 106 participants managed to fill in the questionnaire which translates to a response rate of 88.33%. The sample was calculated at ninety-five percent confidence level (CL) with a margin of error (MoE) of five percent. Electronic calculators were used to calculate the sample as well as the Krejcie and Morgan table.

Table 5.1: The Sample of Secondary Schools in the District.

Total no. of sec. schools in the district	Sampled schools	Total responses	Tools used to calculate a sample		Confidence Leve (CL)l	Margin of Error (MoE)
173	120	106	Krejcie & Morgan table	**Calculators:** Survey-monkey; Smart-survey; Qualtrics Calculator.net	95%	5%

Theme 1: Personal History in relation to the Subject.

All the participants held permanent posts in their respective schools. Schools remained anonymous as they were assigned pseudonyms. There were 65 females and 41 males who participated in the pilot study, responding to the qualitative questionnaire.

Figure 5.1 represents the teaching experience among geography teachers which will assist in understanding how and why geography teachers teach mapwork calculations in the way that they do. In addition, teachers were asked how often they teach mapwork calculations in Grade 10, which resulted in the formulation of theme 2.

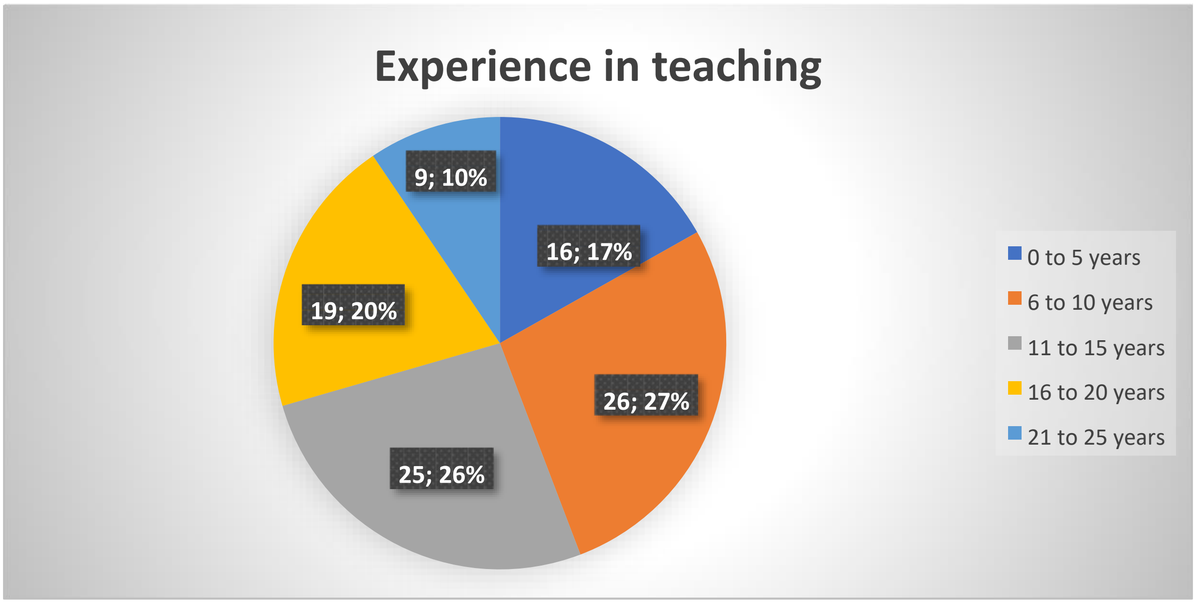


Figure 5.1: The Distribution of the participants' experience in teaching Geography.

Theme 2: School Context as it relates to the Use of Technology to enhance the Teaching of Mapwork Calculations

In response to the question on *how often they teach mapwork calculations in grade 10 classes*, the participants had the following options:

- Everyday, or week
- Every month
- Once per term
- Once a year
- Only before a test or examination

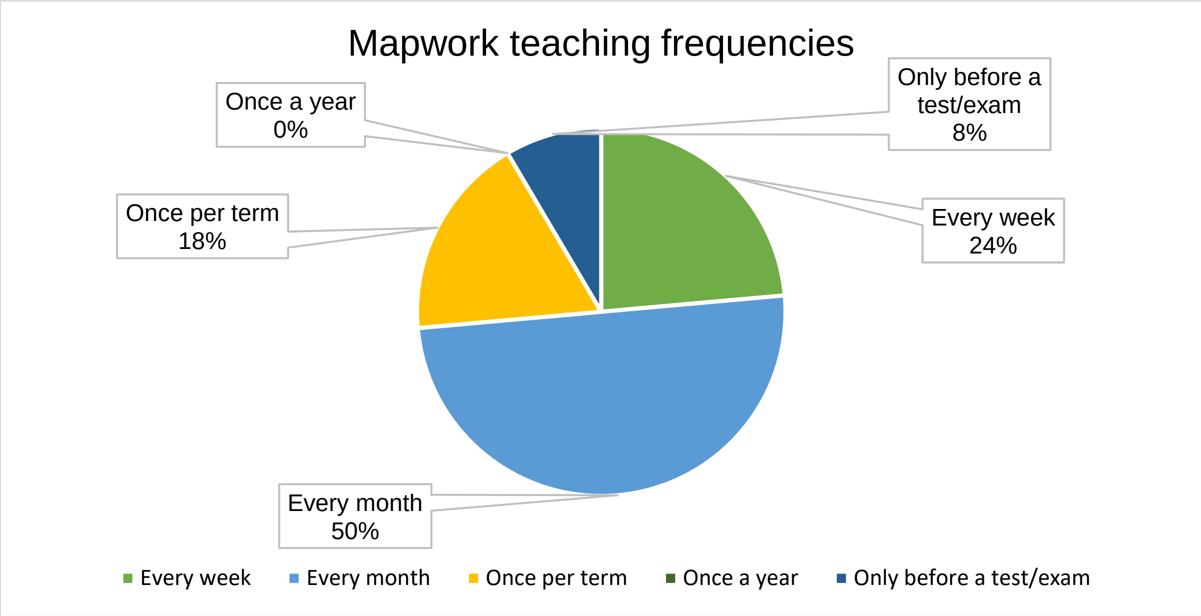


Figure 5.2: The frequency of teaching mapwork in Grade 10 classes.

When asked to rate themselves in terms of their computer expertise, the participants indicated their responses on different aspects as presented in Table 5.2 below. This table reflects the teachers' expertise in word processing, excel spreadsheets, powerpoint presentations, internet browsing and programming to establish their computer literacy in integrating technology in the teaching of mapwork calculations.

Table 5.2: Computer Expertise of the Participants showing the number of Geography Teachers

Experience/expertise in:	**Responses indicating: *Very good***	**Responses indicating: *Good***	**Responses indicating: *Average***	**Responses indicating: *Weak***
Word processing in %	21	29	44	6
Excel spreadsheet in %	16	22	36	26
Powerpoint presentation in %	21	24	43	12
Internet browsing in %	55	32	7	6
Programming in %	0	7	55	44

Figure 5.3 below shows the distribution of geography teachers with computer literacy skills in the Word Processing programme. The distribution skilled geography teachers is tabled according to the sexes, which will enable an understanding into whether gender orientation has any effect in the integration of technology. In addition, they were asked to indicate their

proficiency in using some computer programmes which resulted in Tables, 5.3; 5.4; 5,5; 5.6 and 5.7.

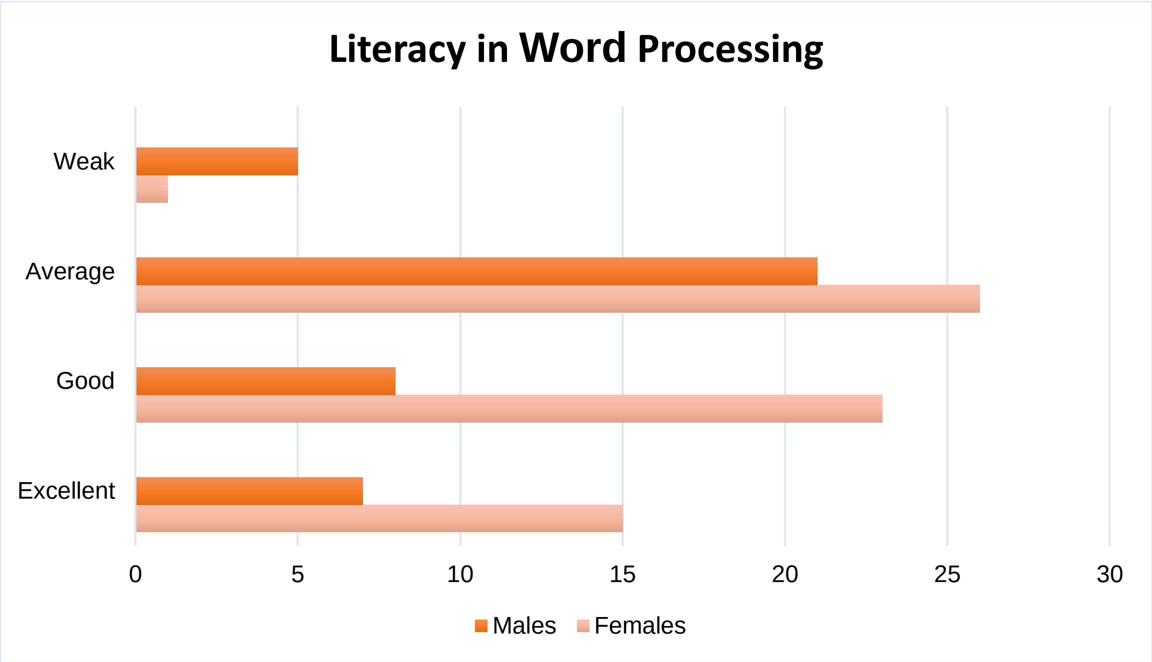


Figure 5.3: The distribution of teachers with literacy in Word Processing.

Table 5.4 presents data on geography teachers who had some skills in using the Excel spreadsheets. Figure 5.4 reveals the varying competences between male and female geography teachers in using Excel to calculate and record geographic scores.

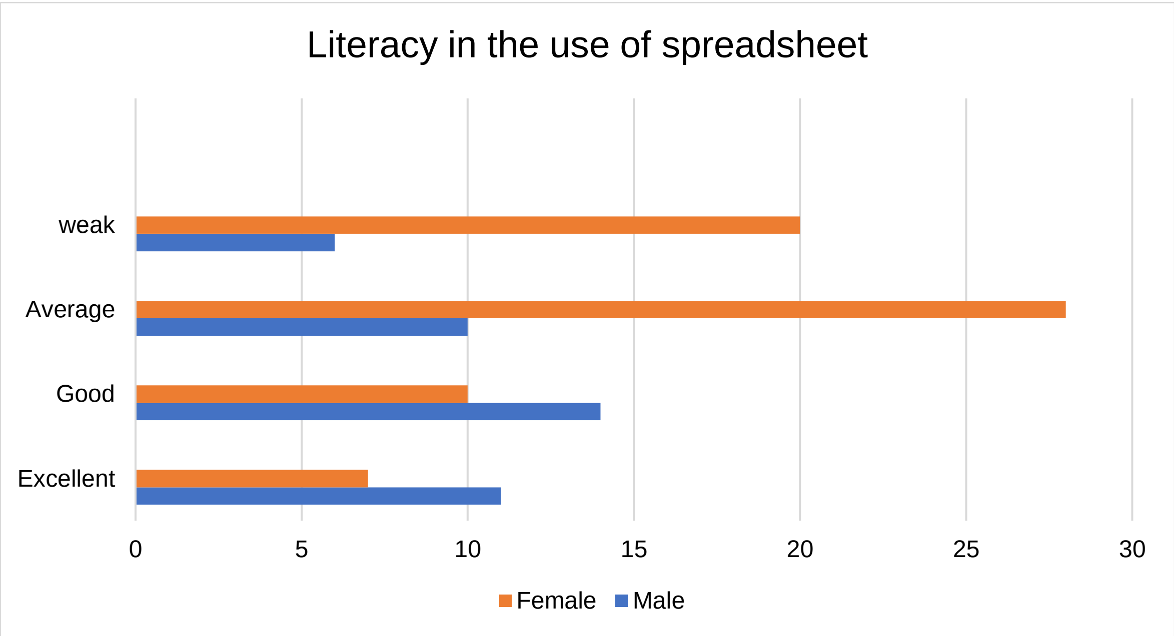


Figure 5.4: Distribution of teachers' proficiency in the use of Spreadsheets (Excel).

Figure 5.5 below presents data on geography teachers' competencies to browse the internet to access geographic data. This data assists in understanding how and why it is important to use the internet in pursuit of current information and access strategies that could help develop their presentation skills pertaining to mapwork calculations.

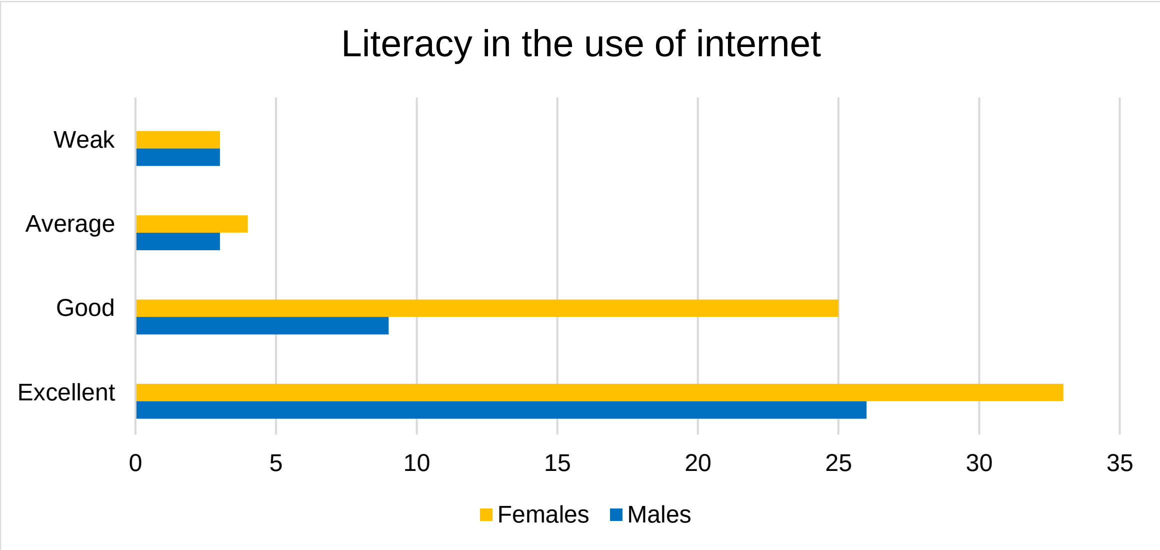


Figure 5.5: Distribution of teachers in the use of internet browsing.

Figure 5.6 reveals the difference in competencies between male and female teachers in programming geographic data. These skills will more likely assist in the teaching of certain geographic themes pertaining to mapwork.

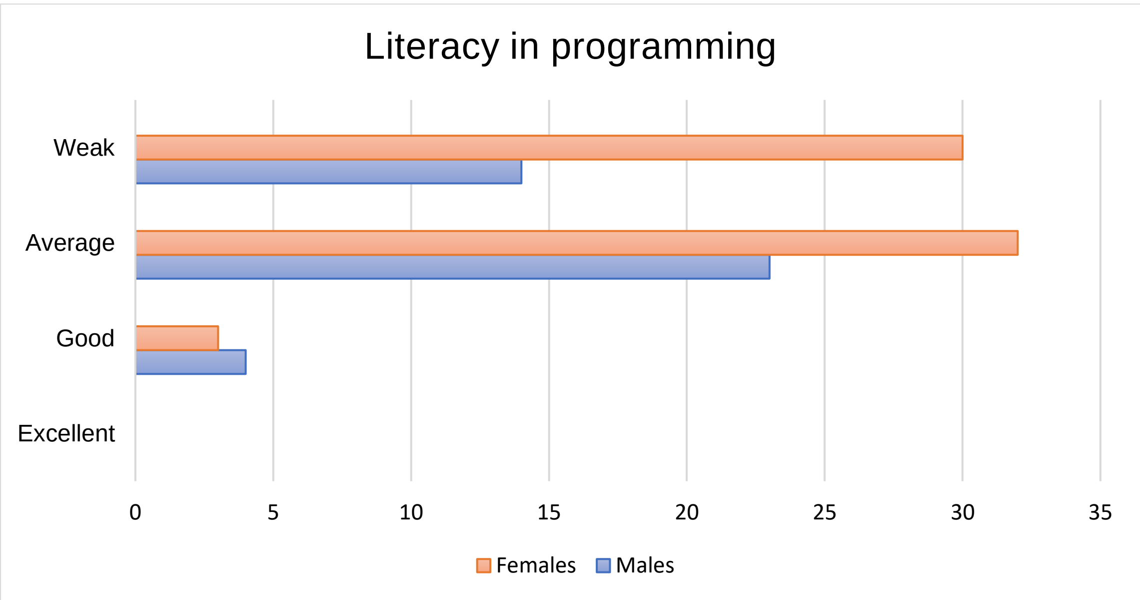


Figure 5.6: Distribution of teachers' competence in programming geographic data.

Figure 5.7 represents data revealing the distribution of geography teachers using the presentation tools in their teachingof geography mapwork calculations.

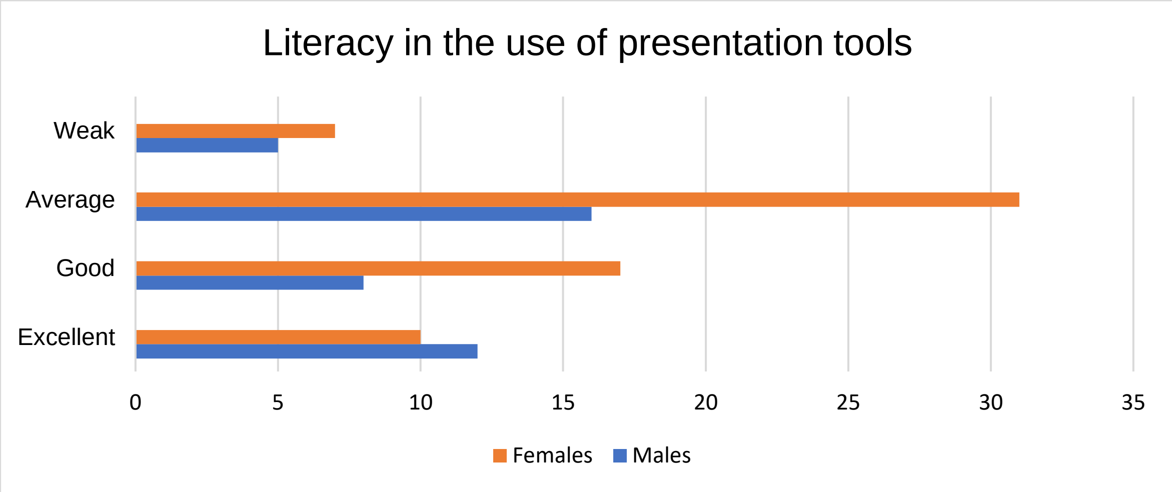


Figure 5.7: Distribution of teachers literacy in the use of presentation tools.

The data on the distribution of knowledge and skills on the use of computer gave rise to theme 3 below on geography teachers' experiences about the use of computer programmes in the classroom.

Theme 3: Personal Experiences regarding the Use of Technology in Geography Teaching

The data in Figure 5.8 below reflects the distribution of geography teachers who own personal computers in the district. Ownership of computers is a prerequisite for geography teachers and assists in facilitating efficient integration of technology in teaching map work calculations.

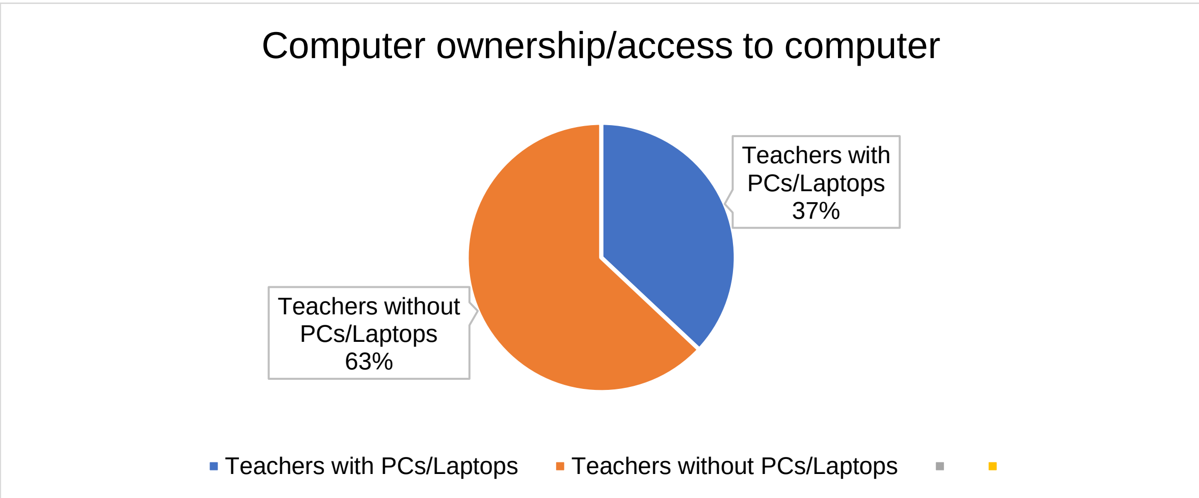


Figure 5.8: Ownership of PCs or Laptops in the sampled schools within the district

The data in Figure 5.9 reflects the number of geography teachers who have access to the internet connection at their schools, their private away from school access and those who have none. An understanding about teachers' access to the internet connection would assist in determining the assistance the schools provide to facilitate technology integration in the subjects they offered. This led to the question of whether schools had subject committees or other resources like overhead projectors and geography laboratories.

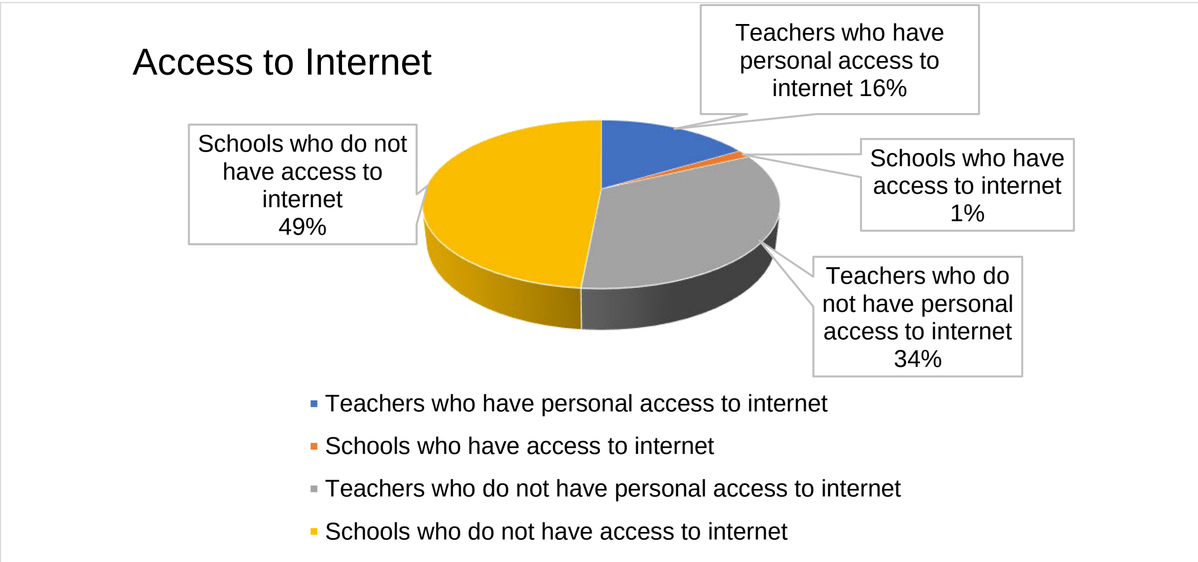


Figure 5.9: Geography teachers' access to the internet

Data in Table 5.3 below reveals the experiences of teachers in schools with or without geography laboratories and the experiences of geography teachers with or without access to a science laboratory. A geography laboratory assists geography teachers to access and store the resources required to effectively teach the subject. In addition, access to a science laboratory assists teachers to use resources that are available in the facility to teach geography learners because some of the resources used in teaching Science are also useful to teach geographic themes. The data shows extreme deficiencies in terms of availability of geography laboratories in schools and access to science facilities.

Table 5.3: The number of schools with Geography laboratories and the number of teachers with access to Physical Science laboratories/apparatuses

Schools with geography laboratory		Schools without geography laboratory	
Number	Percentage	Number	Percentage
2	2	104	98
Teachers with access to science laboratory		Teachers with no access to science laboratory	
Number	Percentage	Number	Percentage
32	30	74	70

Figure 5.9 reflects schools in the district with and without overhead projectors (OHPs) and those with or without subject committees. The availability of overhead projectors allows a level of technology integration while subject committees facilitate the acquisition and maintenance of the required resources.

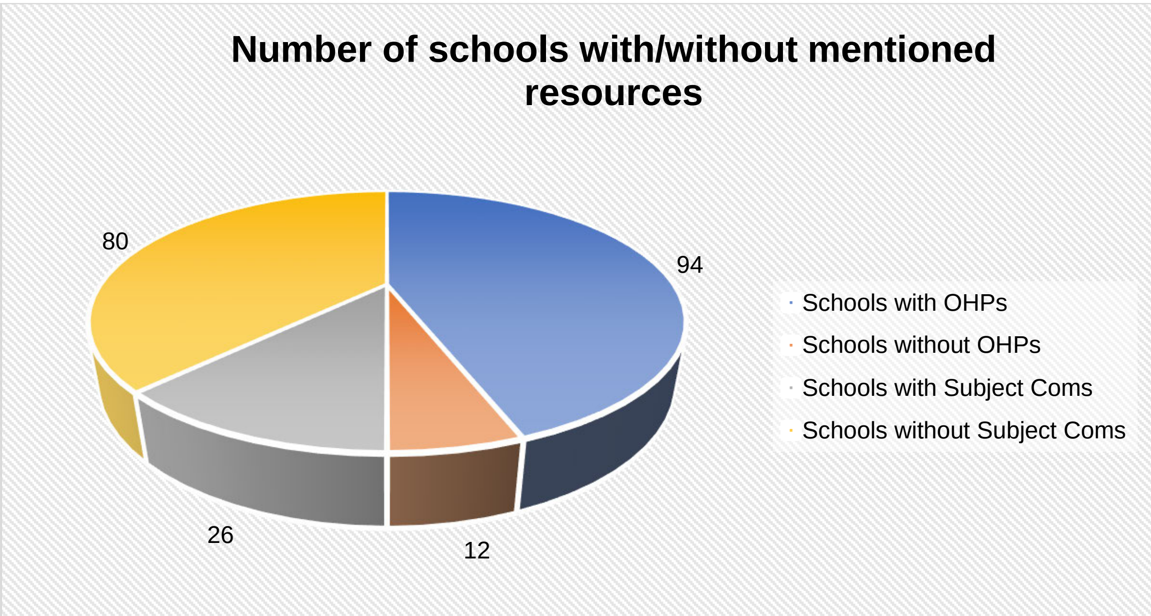


Figure 5.10: The distribution of resources in schools to assist technology integration in teaching mapwork calculations

Figure 5.10 below reflects data revealing the level of training that some geography teachers received from the DBE's Professional Learning Committee. The levels of training were categorised into Basic, Intermediate and Advanced training. The levels of training in the integration of technology in geography vary significantly. A very low percentage of teachers received advanced training while the majority received no training at all. The unequal training opportunities that teachers were exposed to, had negative implications in the experiences of teachers when attempting to integrate technology in the classroom setting. Consequently, it was necessary to explore the experiences of teachers in the classroom.

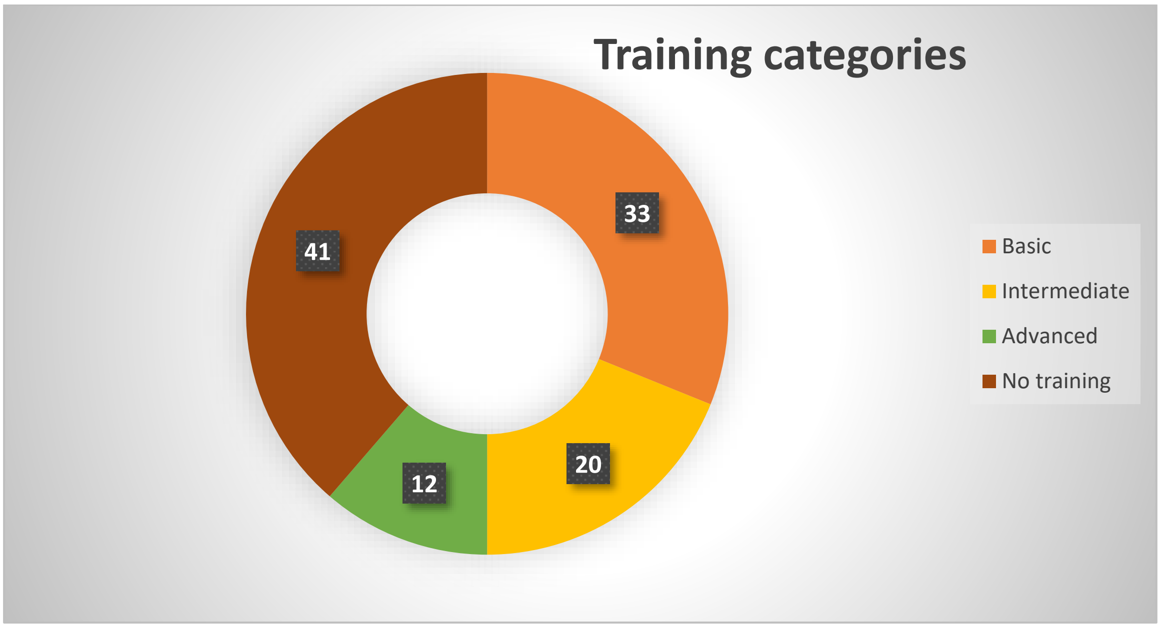


Figure 5.11: The distribution of teachers according to their levels of training in technology Integration

Data in Table 5.4 reveal the distribution of geography teachers who could download tools and resources to use in teaching geography mapwork calculations. In the light of the displayed data, it begs the question how teachers manage their geography classes.

Table 5.4: The distribution of teachers using technology to download and design lessons.

Downloading tools/resources for geography teaching and learning	15=14%	52=49	18=17%	21=20%
Designing your lesson plan using any of the technological devices (smartphone/ iPhone/ tablet/ computer, etc.)	22=21%	35=33	47=44%	02=2%

Theme 4: Class Management in relation to the Use of Technology

Ten questions were posed regarding the experiences of teachers in managing their classes. The questions attempted to answer the question as to why geography teachers taught mapwork calculations in the way that they did. Table 5.5 reflects the experiences of teachers in using technology to manage activities in their classes. The level of the teachers' confidence is indicated in the Likert scale that was used in the questionnaire. However, it remained to be proven during observations in the classroom. In addition, nine prompts were given to teachers to respond to. The aim was to understand the implications of the experiences embedded in their practices regarding the integration of technology in the teaching of mapwork calculations. Their responses are presented in table 5.5 below:

Table 5.5: Teachers' responses to the question on their classroom experiences.

USE THE OPTION THAT SUITS YOUR SITUATION/EXPERIENCE	Strongly agree	Agree	Disagree	Strongly disagree	Did not respond
I can prepare lessons that involve the use of ICT by learners	09=8%	15=14%	56=53%	26=25%	
I know which teaching and learning situations are suitable for ICT use in Geography	06=6%	25=24%	54=51%	21=19%	
I can find useful curriculum resources on the internet/ smart-phone	06=6%	25=24%	53=50%	18=17%	04=4%
I can use the internet to support learners	08=8%	28=26%	55=52%	12=11%	03=3%
I can use a computer in monitoring the learners' progress in Geography	22=21%	72=68%	07=6%	05=5%	
I can use computer applications in teaching certain geographic aspects/themes	20=19%	27=25%	51=48%	05=5%	03=3%
I can use ICT in effective presentations / explanations	11=10%	22=21%	46=43%	25=24%	02=2%
I can use ICT to communicate with other teachers	15=14%	88=83%	03=3%	00%	
I can teach geographic mapwork calculations using technological devices (ICT tools) such as the computer, OHP, videos, slides, mobile phones, and others.	25=24%	42=40%	32=30%	07=6%	
I can use electronic maps to teach mapwork calculations and map interpretation to my learners	13=12%	32=30%	46=44%	13=12%	02=2%

Theme 5: The Experiences of Teachers regarding the Use of Technology in Mapwork Pedagogy

The data in Table 5.6 reflects practices of geography teachers in their classrooms. Nine prompts were given to geography teachers to respond to a Likert scaled questionnaire.

Table 5.6: The implications of technology for geography teachers in teaching mapwork Calculations.

USE THE OPTION THAT SUITS YOUR SITUATION/EXPERIENCE	Strongly agree	Agree	Disagree	Strongly disagree
The school has sufficient maps (in hard copies) for teaching and learning	09=8%	18=17%	58=54%	21=19%
I use 2-Dimensional maps to teach calculations and interpretation	30=28%	69=65%	05=5%	02=2%
I re-arrange the class to form groups when teaching mapwork calculations and map interpretation	82=77%	15=14%	07=7%	02=2%
I allow the use of calculators when teaching mapwork	39=37%	61=57%	03=3%	03=3%
I allow the use of smartphones/mobile-phones when teaching mapwork	11=10%	26=24%	59=56%	10=9%
I encourage discussion among learners when teaching mapwork	28=26%	52=49%	15=14%	11=10%
I exchange groups (swap group members) for each lesson on mapwork calculations and interpretation	24=23%	30=28%	40=38%	12=11%
My learners understand better when taught in groups	46=43%	28=26%	25=24%	07=7%
I assess learners on mapwork calculations and interpretation while they are seated in their groups	32=30%	54=51%	16=15%	04=4%

5.3 Themes from Focus Groups Data

Fourteen themes were developed from the focus groups and semi-structured interviews. The said themes are presented below, however the interpretation of these themes will be continued in the following chapter on data interpretation and discussion. They are presented in this chapter as they developed from the focus group and interview data through the coding process. Pseudonyms were assigned to all the participants, who responded to the questions as set out below:

5.3.1 Support

<u>Do you feel you have adequate professional support in attempting to integrate technology into your teaching of mapwork calculations? Please explain.</u>

Apart from a lack of support by the school policies on the use of technology in teaching and learning, teachers sought assistance from parents who they assume would allow and provide their children with cellular phones, particularly the Smart phones, to access data sets and manipulate data from the internet. A teacher, Sthabiso, from Focus Group 3, indicated that smart phones can assist in learning mapwork calculations,

> *Another thing is that most of the apps are accessible via Google and they can download them into their cell-phones. Using apps is preferable as they show accurate distances and can access different maps at the same time.*

To emphasise the level of support required from parents, Ncane indicated that,

> *If parents manage to buy their kids expensive clothing and sneakers, they can afford to buy them smartphones for educational purposes. It only requires extensive explanation on the part of the teacher. The teacher has to explain to the parents why they need to use cell phones at school.*

Support in teaching geography mapwork calculations is not only solicited from parents. Schools themselves need to provide support to teachers regarding the integration of technology. The required support should be enshrined in the school policy as Zungama from Focus Group indicates that,

> *It also needs to be enshrined in the school policy so that when parents buy stationery for their children, they also buy cell phones for academic work.*

To integrate technology, participants used WhatsApp when communicating on academic matters or seeking assistance from one another. They found it convenient to form WhatsApp groups for communicating and sharing documents on certain geographic topics. It was evident that where one needed assistance from colleagues, it was easier and quicker to communicate and to share information via the WhatsApp group platform. However, Thandi from Focus Group 3 indicated that it became difficult to share information with the learners, despite having formed WhatsApp groups for that purpose. It was apparent that only some of the teachers used WhatsApp groups with their learners, but not all.

5.3.2 Policy on the Use of Technology in Geography Teaching and Learning

<u>Follow-up question: Does your school policy support the use of cell phones by learners in the classroom?</u>

Responding to the question on whether learners could bring cell phones to school for educational purposes, the participant from Focus Group 1, Jabu, pointed out that, *No, cell phones are not allowed altogether. They are punished for bringing cell phones to school.*

However, devices were permitted for use by teachers including cell phones. A teacher could use whatever available device to teach learners. The school policy with respect to cell phone use by learners could be a stumbling block for teachers attempting to use technology to teach. Tate, a participant from Focus Group 2, confirmed that once he had to use his cell phone to explain a particular theme because the school did not have sufficient maps, and appreciated that when using search engines like Google, one could reach many places and look beyond what maps could show.

5.3.3 Resources

A participant, Jabu, from Focus Group 1 revealed that it depended on whether they would hear about requisition, as they did not even know when it was done. Ntombi from Focus Group 2 indicated that:

When teachers place orders for the learning material, they are instructed to request for the textbooks.

Thandi from the same group resonated with this assertion that,

*Most of the time textbooks are purchased… (*but also indicated that even when those textbooks were requested and ordered from the Department) *…but, they have not been delivered for the last two years.*

Teachers were limited to what they could order from the recommended booksellers. However, practices were not consistent because Tate, from the same group, indicated that in his school they submitted the list of orders to Management in line with the allocation per subject, however, the allocation could not afford to provided them with all they needed. So, they only placed orders for the items that would just enable them to do their work.

5.3.4 Training Workshops

In attempting to establish how often teachers attended the Professional Development meetings in the district, the following responses were received:

Teachers revealed that they had not been adequately capacitated in the integration of technology in the teaching of Geography. Opportunities to attend training sessions in the use of technology in teaching and learning were provided. However, only selected schools were invited. This was confirmed by Jabu, a participant from Focus Group 1, pointed out that,

> *Not all schools are invited to a meeting. At times, when the school is invited, only one teacher is expected to attend and cascade the information to other teachers*.

Teachers were keen to become capacitated in the integration of the technology training sessions, as one participant, Hhamu, in Focus Group 2 suggests,

> *The Department needs to capacitate us and provide resources if it really means business in education*.

Teachers expressed their disappointment in the lack of training workshops that would potentially provide them with skills and knowledge on how they could integrate technology in their teaching. The frequency of professional development meetings was also very low. They expressed the need for professional development in the form of short courses, conferences and workshops largely focused on skills and practice on the use of technology. Hhamu from Focus Group 2 expressed the need for professional development by the Professional Learning Community, stating,

> *I only heard about people attending a course, but we are still waiting for the invite to that course. Otherwise, we cannot integrate any technology in our lessons because we were never capacitated as to how we can do it. It doesn't look like we are going to get to the training in the foreseeable future. The department is always complaining about money. Things are becoming even more difficult regarding the integration.*

This view of the district was corroborated by what Sthabiso from Focus Group 3,

> *It doesn't work properly. I would be brave to say it doesn't work properly. It may exist but it doesn't work fully so that it assists the teacher*.

Sharing the same view, Mpintshi said,

> *This thing of the PLCs didn't work at all. I won't lie, it just didn't work. We tried it. Maybe we met twice or thrice, and it failed. We only have those WhatsApp groups in the district. We just share strategies and skills as to how to introduce and teach certain topics.*

The lack of continued professional teacher development (CPTD) in training and not providing teachers with technological skills, impacted on the level of technology integration in the teaching of Geography in the classroom. Furthermore, a lack of training workshops negatively influenced the teachers' interests in technology. Most of the teachers had not been trained in ways they could integrate technology in instructional programmes as yet, as Ntombi from Focus Group 2 states,

> *Most of the teachers are not trained, especially those who have a long service in the field. They are not trained on how to use the gadgets. I really don't think there is much support at all.*

She admitted that she did not know where to start with the integration by saying,

> *I don't have the expertise of how to integrate technology in my teaching. Apart from the scarcity of resources, I do not know where to start with the integration.*

Conversely, the assertion by Van Greunen et al., (2021, p.4) bears testimony that technology integration into schools is likely to take longer than expected. They opine that "it takes an average of four to five years for most teachers to reach a level of technological proficiency at which they can use computers fluidly and effectively".

5.3.5 Interest in the Use of Technology

<u>How do learners react when using technology in teaching mapwork calculations?</u>

When properly integrated, technology is exciting to the learners, as it makes learning fun and easy, thereby promoting learner participation. Learners enjoy technology, as is evident in Shiny's assertion, from Focus Group 3,

> *Instead of wasting time playing games, learners will concentrate on their work because they love technology. They spend time on their cell phones, and they don't get bored because it's interesting to them.*

All focus groups concluded that technology raises the interest of learners when integrated into the teaching and learning of geography. This is evident in Mpintshi's assertion that,

> *There are career opportunities that are open to a learner who has mastered Mapwork calculations. So, technology makes the lesson very interesting. Even those learners who*

fear calculations can significantly develop through technology. For instance, when calculating Magnetic declination and vertical exaggeration, they will know how to go about doing those calculations. They will understand what we mean when we say we exaggerate. When we introduce Magnetic Declination, they begin to understand that even pilots use it. When pilots want to find True North against Magnetic Declination using a compass, they rely on the inclination whether it's towards east or west. So, the use of technology in Geography makes the lesson very interesting.

5.3.6 Benefits of Using Technology

In establishing the benefit of using Technology to teach map work calculations it was evident that some social media platforms assist in operationalising the teaching of geography through teacher liaison and exchange programmes to improve the learner pass rate. This is evident in Thandi's assertion from Focus Group 3 that,

> *As soon as I get the documents, I have to store them in the device so that I can share them with my learners via WhatsApp group.*

This is further affirmed by Mpintshi saying that,

> *It helps that we have best lead-teachers who assist. Like, we have a WhatsApp group of Umlazi and a WhatsApp group for the province, whereby we share resources, we share information. This is how we enhance the geography pass rate in Umlazi District because we don't have a Subject Advisor. I don't know about other districts. We're doing team-teaching and cluster co-ordination. We request one another to revise particular sections in our programme.*

5.3.7 Visualisation of Geographic Content

A further theme was recognised in attempting to answer the question, what are the benefits of using Technology to teach mapwork calculations?

Teachers perceived the use of visual technology as beneficial to them and the learners. Mpintshi from Focus Group 3 expressed her view by saying that,

> *If learners see things happen practically, even without proper understanding, they can explain what they have seen in their own words according to their understanding of the phenomenon. It's quite different from just reading words from the textbook as to how*

the phenomenon occurs. That will be easily forgotten, but once learners see the visuals, they understand better.

This is substantiated by Tate from Focus Group 2, saying that,

> *It's like, if a teacher has trouble in explaining something, s/he will make use of the projector or the laptop and display the image to the learners… So, is you want to show them how the karoo looks like, you can easily tap on your laptop and they can see it projected there.*

Furthermore, Sthabiso from Focus Groups 3 indicates that the integration of technology in the teaching and learning of geography mapwork will yield positive results. He says that,

> *Technology provides learners with the visuals, they become exposed to visuals. So, they can see what you are talking about as it is displayed through the gadgets that you use*.

Shiny from Focus Group 3 argued that,

> *Technology has great influence indeed. Let's take for instance, the issue of teaching a tropical cyclone. Once you display it digitally, they see how it forms, going through all the developing stages. They see how it moves on its path between the tropics. They can see all the characteristics of a tropical cyclone right from the formation stages on a specific date. They can see its impact and the destruction it causes along its way. They see its intensity, starting to move, as we say it moves from east to west. Now, why does it shift, going back to the ocean?*

A similar perspective is evident in Jabu's assertion from Focus Group 1 that,

> *Right now, they just listen to what I am saying and that's it. If I ask them whether they know the waterfall they just say "yes". But when they see it, they would want to know more and be interested to find out how it happens*.

5.3.8 Access to Technology

The theme "access to technology" was derived from the following interview question:

How does the use of Technology affect the geography teacher's pedagogic practice in the classroom in terms of learner participation?

Some teachers opt to use their own resources to acquire the information they need for their learners since some of the schools do not provide access to the internet, while others are not connected at all. For instance, Fezile from Focus Group 1 indicated that,

> *We use our own data bundles to access the internet. It is problematic because the connection is not clear in our area. Sometimes you have to move out of the classroom to connect. It's really difficult to use online facility in the classroom.*

Ntombi from Focus Group 2 voiced a similar sentiment saying,

> *I wouldn't say there is much support from the structures as I am using what I have right now. Previously I was using my own laptop, or I would borrow one from other colleagues. Fine, the projector is available though it belongs to the Science department. I just must make things happen myself, whatever I can bring to the classroom from my learners. And it's a challenge because there is no support.*

Due to a lack of access to some progressive technologies, teachers opt to use the most frequent medium to communicate with one another and with their learners in schools. This is evident in Dzanibe's from Focus Group, that,

> *What we normally do to make things faster, is that we form WhatsApp groups as a class, but other learners complain that they do not have phones or their parents refuse to lend them theirs because obviously, they are using them. There will be that selected few that is left behind because through the use of WA groups, at least we are able to share content such as videos that you could have used in class if you had a projector.*

When using some form of technology in a classroom, learners become interested and their level of participation increases. As Thandi from Focus Group 2 said,

> *Definitely, students become more interested. I don't want to lie. Even if you make an example of their cell phones, like their profile pictures, they become more interested. Especially when you use practical things that they know.*

Shiny, from Focus Group 3 supports the idea of enhanced learning through technology integration in geography map work, saying, *Once students have learned something through the gadgets, they do not forget what they have leant. Even in the exam, they will remember the content of what they learnt. In that way, the use of technology improves learner pass rate.*

To realise the idea of teaching geography mapwork calculations through technology integration, the themes discussed in this section could be perceived as typical factors that need careful consideration as they affect and influence one another.

5.3.9 Improved Learner Performance

The theme learner performance was derived from trying to establish whether the use of ICTs have any effect on the learner pass rates.

Classroom instruction that is facilitated with technology is believed to enhance student learning. This is confirmed in Tate's (from Focus Group 2) assertion that learner results can significantly improve when using technology, because learners learn in different ways. He states that,

[T]hey see the actual occurrence of the storm in the gadget, unlike when they have to imagine everything that I describe to say tropical cyclone moves from this direction to that direction. To them, they see it live. It helps even those who cannot imagine things to see them live on the screen. So, it makes learners' lives easier as it reinforces memory in their minds. So, it's not easy for them to forget, thereby improving the results.

The use of different forms of technologies and social media platforms by teachers exchanging messages regarding the subject-content impacts positively on the performance of geography learners. In their quantitative research study on the use of WhatsApp Messenger, Bonsu et al., (2021) conclude that educators should find a platform that is easy to use, that is useful, and free from technological barriers in order for students to successfully learn with technology, namely, WhatsApp Messenger, during the pandemic. Shiny from Focus Group 3 pointed out that the use of technology in class assists learners to remember what they learned by saying,

Once they have learned something through the gadgets, they do not forget what they have learnt. Even in the exam, they will remember the content of what they learnt. In that way, the use of technology improves learner pass rate.

Tate from Focus Group 2 is of the same view that technology improves learner performance, saying:

So, I am of the view that the results can significantly improve because learners learn in different ways.

5.4 Document Analysis

Document analysis is a form of qualitative research that uses a systematic procedure for reviewing, analysing, or evaluating documentary evidence — both printed and electronic (computer-based and Internet-transmitted) material to respond to specific research questions (Bowen, 2017; Frey, 2018). As a way of gathering information to formally describe a text, Taber, (2007) notes that document analysis involves identifying the content of some documents and naming their components with the purpose of analysing them to respond to research questions. In this research, the following documents were analysed:

• The Geography Annual Teaching Plan

• The daily preparation books (the actual lesson plans)

• Online worksheets/activities on mapwork calculations

• Teachers note on map work calculations

• Grade 10 Mark lists of tests and the examination marks for 2021

These documents were relevant in identifying the year's syllabus that teachers are expected to cover, and the time allocated for the teaching of mapwork calculations at Grade 10 level. The lesson plans teachers prepare for the teaching of a particular aspect in mapwork calculations was vital to the analysis. The notes teachers provide to their learners were important for the analysis, to determine whether they are clear and comprehensible to the learners, but most importantly, whether they relate to the use of technology in executing the calculations. Learners' activities were also important to determine the extent to which teachers integrate technology in some way. The mark lists were analysed to determine the level of learners' performance, as they were taught through technology-integrated pedagogy. Teachers' lesson preparations, learners' written activities and geography notes on mapwork calculations would assist in verifying responses teachers provided during the semi-structured interviews.

5.4.1 The Geography Annual Teaching Plan

Teachers at the research site, the Night Owl Secondary School, use Geography Annual Teaching Plans supplied by the DBE. The purpose of the teaching plans (ATPs) currently used in the school is a three-year Curriculum Recovery Guideline which outlines how teachers should manage the recovery pertaining to the loss of learning due to the COVID-19 pandemic. The 2021 Recovery ATP is aimed at guiding teachers through a period of three years from 2021 to 2024, as stipulated in Circular S11 of 2020. The school suffered a considerable degree of non-teaching and learning when hard lockdown impacted on the South African society in the first quarter of 2020. However, teachers in the school devised some survival strategies and were able to teach their learners using online means of communication.

The ATP presents the Vision for 2024, which pertains to Curriculum Modernisation that will be implemented in 2024. The vision presents the conceptualisation of a Curriculum Strengthening process that encompasses competencies required for the changing world. The vision is aimed at developing Revised Modernised Curriculum Policy Statements in alignment with the amended CAPS Section 4 and 2020 Assessment circulars, as a guide. Furthermore, the vision aims to develop an Assessment for Learning and a pedagogical strategy during this period, and finally to develop Educator Mediation Programmes. The 2021 ATP maintains the use of current Teaching and Learning Support Materials (LTSM) and all the resources already available in the system. The topics that were removed in 2020 were not returned in the Recovery ATP, and only the fundamental and core topics were retained. The vision also presents principles to guide and support the effective teaching and learning of the subject.

Five principles are presented in the Geography Recovery ATP for Further Education and Training (FET) phase. These principles are:

- Use of the 2020 Curriculum Recovery Framework as the base document
- Learning losses inform the Three-Year Recovery Plans for School-based Assessment
- Management of learning losses and the School-Based Recovery Plans
- Create opportunities through adjusted ATPs to strengthen pre-knowledge, consolidation, revision and deeper learning
- Entrench Assessment for Learning as a Pedagogical Approach to address the learning losses

Six assumptions were specified in the ATP after the abrupt closure of schools due to frustrations caused by the pandemic. The supporting assumptions were that;

- All learners would return to school from day 1 of the year 2021 academic year and norm times as stipulated in the CAPS documents would be adhered to for the entire school year.
- Learning losses due to COVID-19 across grades and subjects would vary from school to school, class to class and even within classes.
- Each teacher would have a record of learning losses and the Heads of Departments (HoDs) and Subject Advisors would monitor progress in learning losses recovery.
- All schools would develop and implement school-based support programmes for all grades/years with particular focus on the exit grades/years, i.e., grades 3, 6, 9 and 12.
- All circulars related to the 2020 ATP including School-Based Assessments (SBA) would be withdrawn and revised to align with the 2021 ATPs.
- Schools would have systems in place to manage the possibility of a second wave of the pandemic in the first and third quarters of 2021.

Amendments were made to the 2020 ATP to align with the Recovery ATP in terms of the school calendar, abridged S4 of CAPS, curriculum assessment principles as prescribed in the CAPS policy for Geography. In Grade 10, amendments were made in terms of time allocated for the retained topics while some topics were removed altogether.

Table 5.7 below presents the topics that were removed in Grade 10 ATP, the time allocation for each topic/theme and the term for which the topic/theme would be taught.

Table 5.7: Amendments made to Grade 10 ATP

CONTENT/TOPIC	TERM	TIME (in hours)	AMENDMENT
Atmosphere	1		No amendment
The structure of the Earth	1	6	Rock cycle and intrusive igneous activity and overview of landforms removed.
Plate tectonics	2	4	Mechanism of plate movements, processes and associated landforms removed.
Folding and Faulting	2	2	Links to plate movement, landforms and processes removed
Earthquakes	2	4	Relationship between earthquakes and tectonic forces removed
Using the Atlas	2	2	All the topics relating to the use of atlases were removed
HIV/AIDS	2	4	The entire topic was removed
Geographical skills and techniques	3	2	Content on skills and techniques was reorganised
Population growth	2	4	Demographic transition model was removed
Geographical Information Systems	2	2	Content on GIS was reorganised and moved to Term 3
Floods		4	Amended to the level of Grade 10 learners

The Assessment Programme (PoA) was also amended to accommodate the recovery of the time lost due to the pandemic and to prepare for the revised 2024 Geography Curriculum. The ATP proposed the following format for the recovery period:

Table 5.8: The Programme of Assessment for Grade 10 in the Revised Recovery ATP

TERM	ASSESSMENT NUMBER	TYPE OF ASSESSMENT	RAW MARK	TERM WEIGHTING
1	1	Essay	100	25%
	2	Controlled test	60	75%
2	3	Mapwork	60	25%
	4	Controlled test	60	75%
3	5	Controlled test	60	100%
4	6	End-of-year examination P1 & P2		

5.4.2 The daily Preparation Books

The question on daily preparation books attempted to respond to the question on how teachers did their preparation, and to understand the extent of technology integration from the lesson planning. This question was posed to participants during the semi-structured interviews at the research site.

Teachers at the Night Owl Secondary School used files to keep their documents in order and make them readily available for scrutiny by the Head of Department and/or the Subject Advisor. Files are divided into clearly marked sections for ease-of-use. The school encourages teachers to type their Lesson Plans (LPs), following a standard format for all geography lesson plans in the district. Teachers record the lessons that had been taught in the space provided for that purpose. This helps the HoD /Subject Coordinator to monitor the progress in the teaching of all the topics in the ATP. The format of the lesson plan specifies the following:

• Introduction to the lesson

• Teaching and learning activities

• Conclusion of the lesson

• Technology integration

The section on Technology Integration requires the teacher to specify:

• the learning outcome (LO), i.e., what learners must be able to do

• learners’ experiences, i.e., what the learners will experience and be able to accomplish

• what technological skills will be addressed in the lesson

• what resources will be used in the lesson, and

• how the resources will be integrated into the lesson

The copy of the lesson format is attached as Appendix 10

5.4.3 Learners’ Written Activities on Mapwork Calculations

Once the teacher has taught a lesson, printed notes were provided to learners. All learners are issued with textbooks. The teachers ensure that all textbooks are kept in good condition and returned at the end of the year. Teachers keep records of the textbooks that they issued to learners in all the subjects offered in the school. Notes provided to learners on mapwork calculations included the calculations of:

• Distance on map and on the orthophoto map

• Gradient

• Area on map and on the orthophoto map

• Vertical exaggeration

• Magnetic declination

• True bearing

Notes on mapwork calculations were clear about the application of mapwork skills and were arranged in detail on each topic. The notes also included map interpretation and the GIS. Questions about each topic were given on the notes for learners to practice in their own time.

5.4.4 Online Worksheets/Activities on Mapwork Calculations

Teachers sent learners some of the exercises via WhatsApp, and learners had to submit the work the following day or at a pre-arranged time. Learners completed mapwork exercises in their exercise-books.

The Night Owl Secondary School caters for the student population from the surrounding township. The community in which it is located ranges from middle- to lower-class citizens. Since many of the learners are unable to afford computers or tablets, teachers used the WhatsApp platform to send worksheets and other activities to their learners. When learners have completed their worksheets on their mobile phones, they return them to the teachers who, in turn, prints out copies to do the marking. The school has numerous printers in the printing-room. Feedback is provided to each learner in class so that they can see where they went wrong in their online responses.

5.4.5 Grade 10 Mark lists of Tests and the Examination Schedule for 2021

The common analysis of assessments in Grade 10 for 2021 is attached below. The attachments show the marks achieved in Geography by Grades 10C and 10D, respectively. The names of learners have been removed to maintain confidentiality. The analysis of learners' performance is done in chapter 6.

Activities	Paper 1	Paper 2			TOTAL Weighted Mark	Term %	Level	Report T Mark
Weighting	50	50	40	60				
Total Mark	90	90	90	340				
BA Year Mark				Yes				
Mark Weight				0				
Term /Date	2021/11/23	2021/11/23	Term4 2021/11/23	Term4				
Gender	T1:A1	T1:A2	T1	SBAYEAR		100		
Female	19	-1	19	71	20.97	20.97	1	21
Female	47	-1	47	193	54.95	54.95	4	55
Female	54	-1	54	218	62.47	62.47	5	62
Male	29	-1	29	110	32.30	32.30	2	32
Female	44	-1	44	177	50.80	50.80	4	51
Female	26	-1	26	86	26.74	26.74	1	27
Female	15	-1	15	21	10.38	10.38	1	10
Female	60	-1	60	139	51.20	51.20	4	51
Female	58	-1	58	180	57.54	57.54	4	58
Male	54	-1	54	155	51.35	51.35	4	51
Male	43	-1	43	135	42.93	42.93	3	43
Female	44	-1	44	124	41.44	41.44	3	41
Male	36	-1	36	66	27.65	27.65	1	28
Male	56	-1	56	138	49.24	49.24	3	49
Female	53	-1	53	225	63.27	63.27	5	63
Female	30	-1	30	130	36.27	36.27	2	36
Female	47	-1	47	170	50.89	50.89	4	51
Male	25	-1	25	60	21.70	21.70	1	22
Male	40	-1	40	152	44.60	44.60	3	45
Female	62	-1	62	213	65.15	65.15	5	65
Female	42	-1	42	152	45.49	45.49	3	45
Female	41	-1	41	148	44.34	44.34	3	44
Female	34	-1	34	113	35.05	35.05	2	35
Male	53	-1	53	192	57.44	57.44	4	57
Female	48	-1	48	216	59.45	59.45	4	59
Female	34	-1	34	127	37.52	37.52	2	38
Female	43	-1	43	194	53.35	53.35	4	53
Male	33	-1	33	115	34.96	34.96	2	35
Male	69	-1	69	235	72.14	72.14	6	72
Female	43	-1	43	175	49.99	49.99	3	50
Male	28	-1	28	54	21.97	21.97	1	22
Female	58	-1	58	183	58.07	58.07	4	58
Male	39	-1	39	159	45.39	45.39	3	45
Female	40	-1	40	184	50.25	50.25	4	50
Male	60	-1	60	220	65.49	65.49	5	65
Male	40	-1	40	105	36.31	36.31	2	36
Male	52	-1	52	142	48.17	48.17	3	48
Female	26	-1	26	124	33.44	33.44	2	33
Female	23	-1	23	96	27.16	27.16	1	27
Male	29	-1	29	140	37.60	37.60	2	38
Female	39	-1	39	160	45.57	45.57	3	46
Female	46	-1	46	196	55.03	55.03	4	55
Male	38	-1	38	154	44.07	44.07	3	44
Female	41	-1	41	108	37.28	37.28	2	37
Male	45	-1	45	159	48.06	48.06	3	48
Male	30	-1	30	109	32.57	32.57	2	33
Male	36	-1	36	138	40.35	40.35	3	40
Female	21	-1	21	108	28.39	28.39	1	28
Female	34	-1	34	152	41.93	41.93	3	42
Male	36	-1	36	96	32.94	32.94	2	33
Female	55	-1	55	247	68.03	68.03	5	68
Male	23	-1	23	135	34.04	34.04	2	34
Male	41	-1	41	108	37.28	37.28	2	37
Male	27	-1	27	130	34.94	34.94	2	35
Male	37	-1	37	135	40.26	40.26	3	40
Female	38	-1	38	131	40.01	40.01	3	40

Figure: 5.12: Term 4 marks of Grade 10C at Night Owl Secondary School

TASKS			Test	Mark				
Activities	Paper 1	Paper 2						
Weighting	50	50	40	60				
Total Mark	90	90	180	340				
BA Year Mark				Yes	TOTAL Weighted Mark	Term %	Level	Report Te Mark
r Mark Weight				0				
Term /Date	2021/11/23	2021/11/23	Term4 2021/11/23	Term4				
Gender	T1:A1	T1:A2	T1	SBAYEAR		100		
Female	38	-1	76	109	36.13	36.13	2	36
Female	34	-1	68	144	40.52	40.52	3	41
Female	31	-1	62	162	42.37	42.37	3	42
Male	35	-1	70	111	35.15	35.15	2	35
Male	23	-1	46	100	27.87	27.87	1	28
Male	42	-1	84	160	46.91	46.91	3	47
Male	25	-1	50	110	30.52	30.52	2	31
Male	24	-1	48	151	37.32	37.32	2	37
Female	42	-1	84	187	51.67	51.67	4	52
Female	34	-1	68	158	42.99	42.99	3	43
Male	17	-1	34	134	31.21	31.21	2	31
Male	47	-1	94	167	50.36	50.36	4	50
Male	28	-1	56	147	38.38	38.38	2	38
Female	51	-1	102	144	48.08	48.08	3	48
Female	45	-1	90	155	47.35	47.35	3	47
Female	25	-1	50	130	34.05	34.05	2	34
Male	51	-1	102	195	57.08	57.08	4	57
Female	29	-1	58	155	40.24	40.24	3	40
Male	38	-1	76	126	39.13	39.13	2	39
Female	40	-1	80	148	43.90	43.90	3	44
Male	37	-1	74	147	42.38	42.38	3	42
Male	23	-1	46	117	30.87	30.87	2	31
Male	30	-1	60	122	34.86	34.86	2	35
Female	52	-1	104	146	48.87	48.87	3	49
Male	42	-1	84	161	47.08	47.08	3	47
Female	53	-1	106	158	51.44	51.44	4	51
Female	53	-1	106	227	63.62	63.62	5	64
Female	50	-1	100	185	54.87	54.87	4	55
Female	21	-1	42	108	28.39	28.39	1	28
Male	38	-1	76	145	42.48	42.48	3	42
Male	39	-1	78	135	41.15	41.15	3	41
Female	36	-1	72	144	41.41	41.41	3	41
Male	26	-1	52	177	42.80	42.80	3	43
Male	36	-1	72	166	45.29	45.29	3	45
Female	48	-1	96	197	56.09	56.09	4	56
Female	44	-1	88	196	54.15	54.15	4	54
Male	35	-1	70	122	37.09	37.09	2	37
Female	29	-1	58	149	39.18	39.18	2	39
Female	40	-1	80	153	44.78	44.78	3	45
Male	32	-1	64	125	36.28	36.28	2	36
Male	25	-1	50	117	31.76	31.76	2	32
Female	44	-1	88	140	44.27	44.27	3	44
Female	51	-1	102	187	55.67	55.67	4	56
Female	53	-1	106	111	43.15	43.15	3	43
Female	19	-1	38	140	33.15	33.15	2	33
Male	19	-1	38	85	23.44	23.44	1	23
Female	21	-1	42	180	41.09	41.09	3	41
Male	31	-1	62	152	40.60	40.60	3	41
Male	16	-1	32	99	24.58	24.58	1	25
Female	27	-1	54	140	36.71	36.71	2	37
Female	12	-1	24	120	26.51	26.51	1	27
Female	43	-1	86	167	48.58	48.58	3	49
Female	28	-1	56	132	35.73	35.73	2	36
Male	23	-1	46	110	29.63	29.63	1	30
Male	31	-1	62	124	35.66	35.66	2	36
Male	27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Figure: 5.13: Term 4 marks of Grade 10D at the Night Owl Secondary School

5.5 Semi-Structured Interviews

Semi-structured interviews were conducted with two participants who teach Geography to Grade 10 classes at the Night Owl Secondary School. The preliminary semi-structured interviews were conducted telephonically due to the COVID-19 restrictions. The full interview was conducted following the interview schedule in the appendices.

5.6 Observations

Seven lessons were observed at the Night Owl Secondary School. The researcher was permitted into the school as the COVD-19 restrictions had been eased down to level 2. Teachers were preparing for the monthly tests, which presented an opportune time to observe lessons on mapwork calculations in sequence.

5.6.1 Classroom Observations

In the lesson plan there were six items that required a teacher to specify what technologies would be used during presentation and assessment. Such items are detailed in Table 5.9 below:

a. Topic of the lesson

b. Technological skills to be addressed

c. Resource(s) to be used in the lesson

d. How the resource(s) will be used

e. Specific skills to be addressed in the lesson

f. What could be improved in the lesson

The lessons observed in the Night Owl Secondary School during the third quarter of 2021 are reflected in Table 5.9 below. Figure 5.10 below the Table shows the extended lesson plan that geography teachers used to prepare for their lessons, specifying the integration of technology. Pseudonyms were assigned to teachers who taught these lessons for ethical reasons.

Table 5.9: Lessons observed at the Night Owl Secondary School

Lesson	TOPIC	**Technological skills to be addressed**	**Resources to be used**	**How the resource/s will be used**	**Specific skills to be addressed**	**What needs to be improved**	**Class**	**Date**
1	Calculating time & Magnetic Bearing	-Using calculator to determine Magnetic North	Globe, Whiteboard & screen projector, Magnetic compass, Topographical maps	•Globe: To explain Earth's rotation. •Whiteboard & projector: To write calculation steps. •Compass: To show movement of the compass needle. •Calculator: To calculate the MD	-Calculation steps -How to hold a magnetic compass	-Lighting in the classroom -Learning space (overcrowding)	10D Khumalo	10/08/21
2	Measuring curved distances on maps	-How to use GoogleMap to measure straight and curved distances	•String, piece of paper, ruler, pair of dividers, •Router, •Whiteboard and projector, •Orthophoto and	•To locate actual route on the map •To download GoogleMap distance calculator •To illustrate how curved distances are measured •To locate distances to be measured by learners	-How to use GoogleMap to measure straight and curved distances	-Learning space -Using pair of dividers (adjusting them to the correct distances)	10C Mpanza	11/08/21

			topographical maps					
3	Calculating Speed, Distance and Time	-Changing formula when calculating Speed, Time, and Distance	•Cell phones in Stopwatch mode •Calculators •Tennis ball	Cell phones in stopwatch mode: To use stopwatch Tennis ball: To calculate speed against stopwatch	•How to calculate the speed of bumping ball over a distance	-Learning space	10C Khumalo	11/08/21
4	Calculating the gradient	-Calculating regular area using a ruler -Using formula to calculate gradient -Converting CM to Metres	•OHP & rulers projector, •calculator, •rulers, • Road signs •Wall map on Physical Geog.	•Calculators: To calculate distances •OHP: To show calculation steps on screen •Road signs: To visualise what is used in the real world	-How to calculate regular area -How to use formula to calculate Gradient: G=VI/HE	-Learning space -Improving confidence in learners	10D Khumalo	17/08/21
5	Calculating differences in height	-Calculating height distances (altitude) using contours, trig. beacons,	•Whiteboard with projector & OHP •Wall maps & models	•Clay models: To show contours lines, Trigs, spot heights & benchmarks	-Using contours, spot heights, trigs and benchmarks	-Lighting in class -Learning space	10C Mpanza	17/08/21

		benchmarks, and spot heights	•Calculators	•Topographical maps: To show how contours appear on map	-Using calculators	Proper arrangement of groups		
6	Calculating a regular area	-How to use an area calculator -How to convert figures in the calculator to KMs or CMs	•Whiteboard & projector •Cell phones with map calculator •Router	•To write calculation steps and show conversions from CM to Ms & Kms •OHP: For transparencies with the classwork •To download map for area calculation	-How to calculate regular areas -How to use electronic area calculator	-Learning space -Control in the use of cell phones	10C Mpanza	18/08/21
7	Calculating an irregular area	-How to calculate irregular areas	•Orthophoto maps •Calculators •Metre-ruler •Whiteboard & projector	•To show the area to be calculated •To do calculations •To draw a grid to lay the grid •To draw an irregular area on the grid	-Using calculator to determine the size of an irregular area	Hard copies of an irregular area to be provided for every learner Learning space	10D Khumalo	18/08/21

Technology integration:

What Learning Outcome does the lesson aim to achieve.

What will the learners be able to do at the end of the lesson?

What technological skill/s were addressed in this lesson/project?

What resources were available in the classroom?

How was/were the resource/s used in the lesson?

What can be improved in the lesson?

Any other comment:

____

Figure 5.14: The extension of teachers' lesson plans at Night Owl Secondary School

5.7 Conclusion

Following the questionnaire responses in the initial pilot study and the focus group discussions, data indicated that most of the schools do not have the technology integration policy to facilitate the implementation of the programme. This has caused most of the sampled schools to lag in integrating technology in the schools' academic and administrative programmes. However, this has not been exposed in the current literature.

This chapter presented the qualitative data collected from teachers in the district and from the purposively selected school, the Night Owl Secondary School. Data was presented in arranged sections of the chapter, from questionnaire, focus groups, semi-structured interviews, observations, and document analysis. The analysis of this data will follow in Chapter 6.

CHAPTER 6

INSIGHTS INTO INTEGRATION OF TECHNOLOGY IN MAPWORK TEACHING

6.1 Orientation to the chapter

The data presented in the previous chapter will be analysed to develop a clear understanding in relation to the extent of technology integration in the teaching of mapwork calculations in secondary schools. Although the sample in this qualitative research is limited to the sampled schools and the research site, the findings obtained after the analysis can be transferred to similar settings when following similar procedure from data collection to data analysis. Data that was solicited from different sources were coded in the previous chapter and the themes that developed will be used for analysis in this chapter. Specific attention will be paid to each strategy that was used to collect data. The data collected will be analysed using textual, graphical, and tabular formats. Descriptive analysis of each data format will be followed, and the procedures of the analyses will be supported by applicable protocols and research ethics.

In the analysis, the conceptual frameworks of UTAUT and TPACK were used to limit the scope of the research so that it did not reach beyond the integration of technology in the teaching of geography mapwork calculations in Grade 10 classes. The use of the UTAUT framed the study with respect to the adoption and use of certain technologies by teachers in their interactions among themselves and with their learners. The adoption of these technologies influenced the attitudes of teachers and changed their behavioural intentions. The TPACK was used to analyse geography teachers' use of technology at the research site. Observational data and data from semi-structured interviews and document analysis was analysed using the conceptual frameworks of TPACK and UTAUT.

6.2 Pilot Study

The researcher conducted a pilot study prior to the actual data collection process. The pilot study was used to determine the validity of the data collection instruments. A pilot study is a small feasibility study designed to test various aspects of the methods planned for a larger, more rigorous, or confirmatory investigation (Arain et al., 2010; Crossman, 2020). In other words, it is a pre-liminary, mini-/small-scale study to determine the feasibility of the larger study. The pilot study assists the researcher to decide whether to proceed with the main study or to modify some components of the main study, and how best to conduct a full-scale project (Crossman, 2020).

A pilot study was conducted with thirty-three participants who responded to a qualitative questionnaire. The responses of the participants in the pilot study were combined with the responses of participants in the main research study. This is consistent with Menon's (2020) proposal that the results derived from the pilot study be included in the main study and that the rate of success and retention be given in the method section. The response rate of this pilot study showed an average of at least 82.5% success. From the forty questionnaires that were distributed to the participants, thirty-three were returned while seven were not, which showed a rate of 17.5% retention. The questionnaire was refined, and the instrument was deemed efficient for use in the main study.

6.3 Analysis of the Pilot Questionnaire

The questionnaire comprised of five themes that participants had to respond to, namely:

1. School context in relation to technology integration

2. Teacher's personal expertise regarding the use of technological devices and software

3. Teacher's personal experience in integrating technology into Geography teaching

4. Implications of technology on the teaching of geography mapwork

5. Teacher's perceptions on technological knowledge (TK)

The questionnaire is analysed using the thematic content analysis (TCA). The analysis will be expressed in qualitative formats using graphs, tables and charts.

Theme 1: Contexts of Schools in relation to Technology Integration

Teachers were asked ten questions regarding the contexts of their schools in relation to technology availability and access to devices. All the questions concerned the use of technology and the prevailing conditions in the schools to facilitate the integration of technology.

Ownership and Access to a Computer

The intention of this question was to assess the likelihood of the geography teachers' use of technology in their teaching. It was assumed that teachers who have their own laptops or desktop computers are familiar with various Microsoft programmes, as they are likely to use computers in their teaching. Teachers who do not have computers or laptops, or even access to these devices, are likely to have difficulties in using them for personal benefit and for their professional work. The responses to questionnaires indicated that most of the teachers do not have personal computers (PCs) or laptops. Only 37% do while, the other 63% of Grade 10 geography teachers do not have computers.

Even though a large percentage of geography teachers did not own or have access to computers, most of them had devices that they used to communicate among themselves and with their learners (See Fig.5.3 on page 125). The ownership of smart-phones, iPhones and tablets was paramount in the use of technology applications. The study conducted by Anshari et al., in 2016 revealed that students use their smartphones to access learning materials and information which is usually accessible on the internet. They use their smartphones as learning aids as the devices provide convenience, portability, comprehensive learning experiences, multi-sources and multi-tasks. Students manage group assignments using smartphones, however, challenges such as distractions, reduced quality of face-to-face interaction, dependency on the device and a lack of hands-on skills, exist when using devices. Owusu-Acheau & Larson's (2015, p.94) study revealed a "direct relationship between the use of social media sites and academic performance", and the findings of the study revealed that the use of social media had negatively affected the academic performance of students at the Koforidua Polytechnic in Ghana. On the contrary, Msuya's (2015) study on *Using mobile phones in teaching and learning in secondary schools in Tanzania,* found that teachers were not competent in uploading, downloading and sharing academic resources, but merely grasped the basic uses of mobile phones. Consequently, they could not enjoy the maximum benefits of using the devices.

Nonetheless, Anshari, et al., (2016) suggest that rules must be established beforehand to prevent these challenges from occurring. Geography teachers are bound to experience both the positive and negative cues when teaching the application of these devices. Teachers have different types of phones they can use to facilitate communication among themselves and with their learners. Having identified internal and external factors affecting teachers with regard to the use of technology, Alharbi (2021) concludes that the insufficient support provided to teachers is hindering the successful use of technology. Although many teachers have the use of smartphones, they are not likely to use them productively in the teaching of geography mapwork calculations unless they have sufficient support from concerned structures in the form of resources, policies pertaining to technology integration in the classroom, capacity development in the form of professional workshops and internet connectivity

Figure 6.2 indicates that out of 106 responses to the questionnaire, 92% of Grade 10 geography teachers in the district had access to smartphones. It is believed that the use of smartphones by both teachers and learners facilitates the conditions under which teaching and learning take place. The use of smartphones is expected to raise the level of engagement between teachers and learners as well as among teachers themselves. This techno-centric view of mobile learning through learner-centred strategies is viewed by Tsikanos & Ally (2013) as facilitating the conceptual leap from traditional, lecture-based, teacher-driven instruction to learner-centred instruction where learners better understand why and how they learn. A similar view is held by Constance & Musarurwa (2018) and Ontong & Khule, (2020). In support of the same view, Shamle et al., (2022, p.8) recommend "training and retraining of teachers to update knowledge on teaching methods and materials". In this study, facilitating conditions as espoused by the UTAUT model are viewed as advocating the provision of the infrastructure and physical resources, coupled with professional development of geography teachers to allow for successful integration in the teaching of geography mapwork calculations.

The key constructs of the UTAUT play a vital role in influencing the behaviour of teachers when deciding on the type of devices they wish to use to communicate among themselves and with their geography learners.

Performance expectancy, as a construct of the UTAUT model, influences the behavioural intentions of teachers in the teaching of geography mapwork calculations. By using their smartphones to communicate with their learners and among themselves, teachers believed that communication improves their teaching and their access to the latest information concerning the subject they are teaching. Sthabiso from Focus Group 3 indicated that,

> *Using apps is preferable as they show accurate distances and can access different maps at the same time. Unlike in the traditional way where you run short of maps of a particular area, then they end up sharing in groups of 6 or 8, which becomes a problem in this time of the pandemic. Using apps can solve the problems of social distancing in the classroom while promoting individual engagement of each learner. So, participation is greatly improved through the use technology.*

It became apparent in the focus group discussions and the semi-structured interviews that teachers used their devices to communicate timeous messages to their learners regarding the tasks they were expected to execute. Teachers relied on the performance system in their devices to keep abreast with the latest information on the subject they teach (See definition of performance expectancy in Chapter 3: Section 3.2.1). Regarding effort expectancy, teachers select devices on the bases of the level of the effort they were expected to put in using the devices. Ntombi from Focus Group 1 confirms performance expectancy of the devices saying,

> *Using the filters that we have in our cell phones we can create or to distort or even manipulate data. Especially with the images, they (learners) understand them (Cell phones) better because they are used to selfies. They can see what you are trying to show them through their cell phones.*

The less effort they put into using the devices, the more they would be inclined to purchase the kind of device to assist them in their engagements with different role players within the education spectrum.

Theme 2: Teacher's Personal Expertise regarding the Use of Technological Devices and Software

It also became apparent that the female geography teachers were more computer literate than their male counterparts. In addition, the female teachers made more use of computers in their teaching than the male geography teachers (Figures 5.3 to 5.7).

Some geography teachers used Word Processing to prepare their lesson plans, tests and assignments, projects and examination papers. Those who did not have either access to random computers or computers of their own, relied on the school administrators to assist with the typing. The distribution of skillls in word processing is presented in Table 5.3 in the previous chapter on page 125.

Most of the teachers were not overly familiar with the use of Spreadsheets. Those who had the skills and knowledge, used it to record learners' marks after a test, assignment, projects or examinations. The distribution of teachers who used the spreadsheet for various purposes in their teaching and learing is illustrated in Figure 5.4. Knowledge in preparing the spreadsheet is vital to teachers as they have to arrange marks attained by their learners on completion of tests, assignments and projects in Geography. A lack of expertise in preparing the spreadsheets hinders professional expression and may result in erroneous calculations since the Excel programme assists in facilitating proper calculations and the production of accurate percentages that reflect learners' scores.

Data revealed that teachers used internet to access pictures and videos pertaining to geographical phenomena based on the concepts taught in class. Those who did not use computers, made use of their smartphones (Android), iPhones or tablets. Figure 5.5 on page 126 reveals that more female teachers are efficient in internet browsing than their male counterparts. Nonetheless, most of the teachers, regardless of gender, have the ability to browse internet, which gives them the advantage to access more data and strategies to teach mapwork calculations.

From the data presented in Table 5.6 on page 126, it was apparent that most of the teachers do not use programming in their preparation and, consequently, make no use of programmed instruction. Some participants enquired during focus group discussions as to what was meant by programming. Table 5.6 shows the distribution of teachers who made use of programming, albeit to a limited extent. Data revealed that most of the teachers had average to poor expertise in the programme, which indicates that they were not likely to programme any work pertaining to mapwork calculations.

Data revealed that most of the teachers knew how to use the presentation tools such as PowerPoint. Those who had access to computers and presentation accessories like whiteboards, made use of the presentation tools in their classes. Figure 5.7 in the previous chapter shows that many male geography teachers appear to be more literate with respect to presentation tools than their female counterparts. However, more females have an average to very good rating with respect to being knowlegable about the use of Power Point presentation tools, though the data revealed that approximately 12% of male teachers were excellent. The contexts of schools in which the participants taught led to the question of how they experienced the integration of technology in their respective schools. This question culminated in the analysis of Theme 2 below:

6.4 Analysis of theme 2

Table 6.2 below summarises the software programmes in which teachers evinced a fair knowledge of these programmes in their preparations for teaching and recording assessment scores of learners' mapwork calculations. When teachers were required to indicate their expertise in using computer software programmes, some differences emerged in the use of different programmes. Many teachers in the sample indicated an average to excellent use of the Word Processing programme, while only 6% indicated that they have no expertise in using the programme. Many of the teachers, comprising 76% could use the spreadsheet in Excel while a minority of 4% indicated weaknesses in using the programme. Many of the teachers in the sample, who constitute 94%, were able to browse the internet while only 6% did not have expertise in browsing the internet. Most participants, who constituted 94% of teachers in the sample, could do programming, while a minority of six percent indicated weakness in programming.

Theme 3: Personal Experiences regarding the Use of Technology in Teaching and Learning

This theme relates to the experiences of teachers in using technology to perform tasks that are applicable to their employment prescripts. The integration of technology varies from one situation to the next, as teachers exist in different school settings and have varying experiences.

Access to the Internet

In the questionnaire, teachers were asked about their access to internet connectivity. Figure 5.8 indicates that a large majority of the teachers did not have personal access to the internet, nor did their schools.

Using technology in the classroom holds several benefits for teachers. Geography teachers in schools can make use of technology to enhance their teaching of geography mapwork calculations in several ways Padayachee, (2017); Kadhim, (2020). However, without internet connectivity teachers are not able to access the latest information and visual content in their subject when teaching Geography in the classroom.

The use of devices like the computers, tablets, overhead projectors, interactive whiteboards and other devices turns a traditionally dull subject into an interactive, enjoyable and fun activity. Barhoumi’s (2015) study confirmed that online social presence is important to assist learners to become more engaged in their learning activities. The same happens with teachers as they share subject knowledge and activities via technological software in their devices. The fact that many teachers did not have personal access to internet connectivity, and with 49% of schools not having connectivity either, revealed that many teachers were not likely to access digital material for teaching mapwork calculations.

Provision of School Internet Connectivity

Connectivity in schools is necessary to facilitate technology integration which includes digital devices and software programmes. Van der Merwe (2016) proposed greater connection in schools by issuing more spectrum to data providers, as the Government is directed by the Independent Communications Authority of South Africa (ICASA), to enable greater competition and make the Fifth Generation (5G) spectrum permanent. As Ontong & Khule (2020) suggest a strong integration of technology in schools, EMFSA (2022) recommends that the use of the 5G technology as an integral that is necessary to fulfil their potential within the 4IR. Access to the internet in schools poses a huge problem in this 4IR period. Bloomberg (2021) indicates that it is costly for the internet users to access fast and reliable connection, and this is a national problem. It was evident from the geography teachers' responses which indicated that 97% of sampled schools did not provide internet connectivity for use by the teachers and learners. The 3% of sampled schools that can provide internet connectivity resort amongst the 25% more affluent schools in the country that Prior (2020) refers to in his/her article, *The problem with South African children learning online.*

It was evident that the non-provision of internet connectivity prohibited the facilitating conditions that would enable teachers and learners to access online content for use in the classroom. Facilitating conditions would enable geography teachers to use internet sources to visualise the content by displaying maps on screen and engage learners in measurements and calculations. The technical structure in schools did not allow teachers to make use of technology to access online content and make it easy for the learners to conduct calculations through technological means. In most sampled schools, the technical infrastructure did not accommodate the use of technology.

Schools with Geography Laboratories

The responses of the participants to the questionnaires revealed that very few schools possessed geography laboratories (See Table 5.3 on Page 129). In addition, most of the teachers did not have access to a Physical Science laboratory either. Hence, geography teachers were not able to make use of the apparatus or technological devices in the schools' Science laboratories. Even the digital library could serve as an important source of information for both geography teachers and learners. Milson (2020) reveals that the Digital Library contains a wealth of visual and audio treasures as it contains a collection of images representing the geographical, historical, and cultural aspects of every region covered in the program. The use of GeoVideos and Explorer Video Clips in the digital library engages teachers and students in excellent ways as the videos introduce students to their corresponding lessons. The availability of geography laboratories and digital libraries is likely to influence more teachers socially to engage their students in more scientific explorations of the content. The availing of a geography laboratory or a digital library as a source of geographic information will potentially influence other schools to make use of the facility. In addition, Kocalar & Demirkaya (2017, p.344) suggest in their qualitative study in Turkey that "a well-equipped geography laboratory… will improve the teachers' proficiency on the teaching and provide them with an opportunity for more effective education in geography".

Access to Communal/CAT Computers

Responding to the question as to whether the participants have access to communal computers, the responses indicated that 92% of geography teachers did not have access, even to computers that are reserved for learners studying Computer Applications Technology (CAT). Nonetheless, participants in Focus Group 1 indicated that the computers for teaching CAT were not programmed for any other subject, as the installed software was specifically intended for CAT only.

Geography teachers in sampled schools do not have access to communal computers because most of the schools do not possess computer laboratories. Padayachee's (2017) study found that teachers appeared to use technology more frequently in their preparation and administration and concluded that teachers have the infrastructure and/or access to devices for these purposes at home, but not at school. Many schools did not have technology infrastructure to assist both teachers and learners in their educational engagements as indicated in the Global Human Rights Clinic Report of 2020 (Guruli et al., (2020).

Schools with Overhead Projectors (OHPs)

Participants indicated in their responses that 89% of schools had overhead projectors while only 11% did not. However, not all teachers had access to these devices as they were reserved for specific subjects in some schools. Their availability depended on access for use by all staff members for their specific subjects. If these OHPs could not be used by all teachers to teach their specific subject, they could not be regarded as readily available technological tools for the subjects offered by the school. Figure 5.9 reflects the percentage of schools with and without OHPs in the district.

Access to technological devices like OHPs, computers and other equipment would assist in mediating the teaching of certain geographical aspects on mapwork calculations. However, it was not feasible for geography teachers to make use of technological devices due to inadequacies of these devices. As Phakathi (2019) indicated in *Business Day* (8 April 2019) "provisions generally afforded to South African primary and secondary schools are woefully inadequate". Access to devices may only be given to the science teachers in some schools; other schools did not have any at all. While some of the schools did have overhead projectors, they were inadequate for use by all the teachers.

Consequently, they were reserved for use by teachers of specific subjects. In addition, the absence of geography laboratories in schools exacerbated the problem for geography teachers as they rely on laboratories for other subjects, like the Physical Science. Table 5.3 shows that only 2% of schools in the district had geography laboratories, which renders geography teachers unable to access the required resources.

Schools with School Subject Committees (SSCs)

The data revealed that 75% of sampled schools did not have school subject committees (SSCs) (See Figure 5.9 on page 128). According to the DBE's (2014) *School Committees and Professional Learning Communities*, schools are "encouraged to set up PLCs based on subject, phase and professional development related issues to have collaborative programmes to improve teacher and leaner performance" (DBE, 2014, p.10). The structure of the committees was designed from national to school level. Figure 6.1 in the next page shows the structure and the relationships that exist between committees. At national, provincial and district levels, the Professional Learning Committee consists of district officials, teacher-union representatives, phase coordinators and subject advisors, as specified in the official document (DBE, 2014 p. 11-13). At school level, the committee comprises teachers in their respective subjects, phase, grade, or area of specialisation. Co-opted members such as Subject Associations, non-governmental organisations (NGOs) and heads of education institutions (HEIs) were invited to participate in these committees. Reporting is two-way through all the structures and recommendations are made from upper level to lower level and *vice versa*. The absence of PLCs in schools and in districts makes it difficult to facilitate professional development programmes as required by the DBE. Sthabiso from Focus Group 3 confirmed the inefficiency of the PLC, saying,

> *It doesn't work properly. I would be brave to say it doesn't work properly. It may exist but it doesn't work fully so that it assists the teachers.*

Furthermore, a participant in the semi-structured interview, Mr Khumalo, confirmed the unavailability of the PLC to assist geography teachers, saying,

> *Well, we currently do not have the Subject Advisor. The PLC is nowhere to be found because we have never been invited to any geography meeting. We just assist one another with information via WhatsApp and emails.*

Figure 6.1 below shows the structure of the PLCs and the relationships among them as proposed by the DBE in its *Professional Learning Communities – A guideline for South African Schools* (DBE, 2015, p. 9).

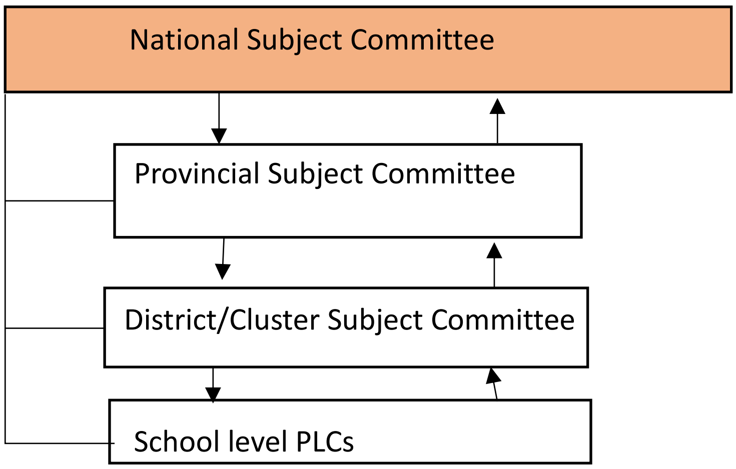


Figure 6.1: Structure and relationships between Subject Committees and PLCs

Darling-Hammond, Hyler & Gardener (2017, p.20) indicate that professional development in schools "has proven insufficient which affects teaching practice and student achievement". Similar conclusions were drawn from Masikirikwe & Sokpuwu's (2021) survey in Nigeria, *Staff Development and Teachers' Performance in Public Secondary Schools in Rivers State*, which recommended that teachers should ensure that they improve themselves regularly while the Government as an employer must ensure sponsorship of the teachers who, in turn, must be "willing to update their knowledge base and skill set" (p.98). This is consistent with the DBE's guideline that 'all teachers should engage in lifelong professional development' (DBE, 2015, p. 14). The poor establishment of subject committees in the sampled schools results in the lack of professional development of teachers in the integration of technology in teaching geography mapwork calculations.

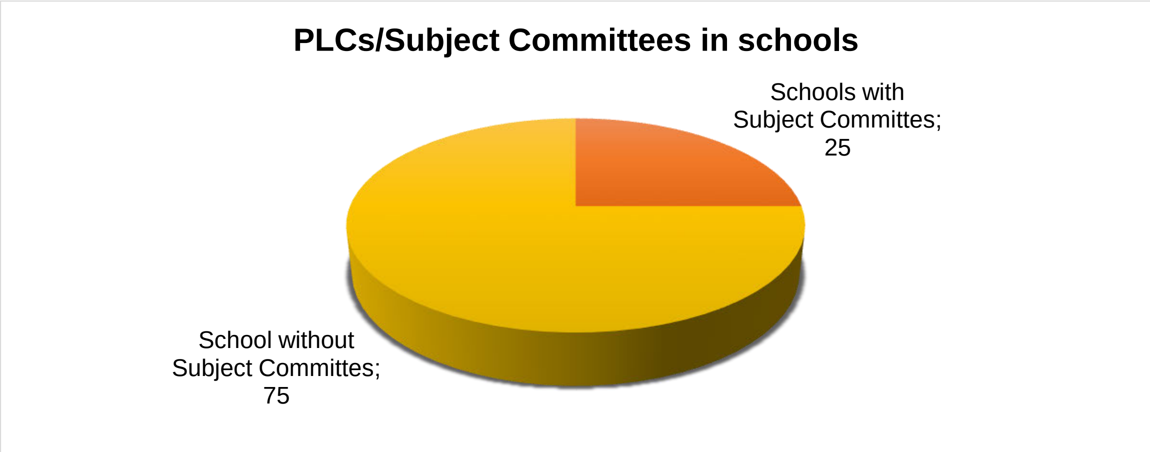


Figure 6.2: Subject Committees in sampled schools

Figure 6.4 above reflects the percentage of Professional Learning Committees that were established in the sampled schools in the district. The non-existence of PLCs in the sampled schools was further confirmed by participants in Focus Group 3, Thabiso and Mpintshi, who revealed that t PLCs do exist but do not function optimally. Expressing her view, Mpintsi said,

> *This thing of the PLCs didn't work at all. I won't lie, it just didn't work. We tried it. Maybe we met twice or thrice, and it failed.*

On the other hand, Jabu and Zanele from Focus Group 1 denied any professional development support from PLCs or Learning Area committees, as they did not exist in their schools.

Teachers trained in Technology Integration

Training of teachers in the integration of technology is dependent on the existence of professional development structures within or outside of their schools. The participants' responses that 88% of the teachers had not attended training on the integration of technology in the teaching of Geography. From the remaining 12 percent of participants, some received minimal training while only a few received adequate training. It is from this group where participants in the focus groups were purposively selected. The less training teachers received from either external or internal structures, the less likely they were to fully integrate technology in their teaching.

6.5 Summary of the Discussion on Theme 3

Geography teachers did not know which lessons in Geography required the integration of technology, and 77% could not prepare lessons that involved the use of technology. Regarding internet browsing, 34% of the teachers could use the internet to support the teaching of geography mapwork while 67% could not find useful resources for Geography on the internet. Yet, 42% of the teachers could use computer applications in teaching certain geographical aspects. It was apparent that 97% of the teachers used technology only to communnicate with other teachers, while only 31% could provide effective presentations using a computer. Nonetheless, 63% could teach mapwork using technological devices like the OHP, excluding electronic maps which only 42% of the teachers was able to use.

Theme 4: The implications Technology holds for Geography Teaching and Learning

Table 6.1 on page 169 expresses the participants' responses to the questions pertaining to the teaching and learning of Geography in their respective school.

6.6 Analysis and Discussion of Theme 4

Many of the schools did not have sufficient maps in hard copies. Only 25% of the participants indicated that their schools have sufficient maps. This indicates that most of the learners share maps, either topographical maps or aerial photographs, when doing mapwork calculations. Munje & Maarman (2017) argue that disadvantaged school communities face challenges due to the inadequate resources or lack of capabilities to convert existing resources into learning outcomes. Inadequate maps in classes deprived learners of an access to visual presentation of the landscape and did not allow independent practice of mapwork calculations, since learners shared the few maps that were available. This tempted them to copy one another's work and disempowered those learners who lag in the conceptualising of the space and place, by applying all the procedures needed to attain the correct measurements that would lead to the correct answer. A lack of adequate resources such as maps also compromised the opportunity for incompetent learners to understand calculations while relating to the visual representation on paper.

93% of the participants indicated that they use two-dimensional maps to teach mapwork calculations and interpretation. Only 7% of the participants were privileged to use three-dimensional maps in their schools. In trying to accommodate every learner in class, teachers arranged their learners in groups so they could share the copies of maps available. 91% of the teachers indicated that they re-arranged their classes to form groups when teaching mapwork calculations and interpretations.

On the use of calculators, 94% of teachers indicated that they allowed their learners to use calculators when doing mapwork calculations. However, some participants in the focus groups indicated that learners had to buy their own calculators because the calculators supplied by the DBE with the stationery were of poor quality and quickly ran out of battery. As a result, 34% of teachers allowed their learners to make use of smartphones/mobile phones when teaching mapwork calculations if they did not have calculators.

Based on the discussions among learners, 75% of teachers indicated that they allowed their learners to discuss the questions when learning mapwork calculations while 51% exchanged groups for each lesson on mapwork. Nonetheless, 69% of the teachers indicated that their learner’s understanding of the work improved when taught in groups. Lastly, 81% of the teachers indicated that they assessed their learners on mapwork calculations and interpretations while seated in their groups. Group work in geography classes was a preferred method in most schools and teachers found it convenient in their classes. It was also evident during observations at the research site, the Night Owl Secondary School, that participants used group work when teaching mapwork calculations. The table below summarises the responses to the prompts of Theme 4 above.

Table 6.1: The implication that technology has for geography teaching and learning

LIKERT SCALE	Strongly agree	Agree	Disagree	Strongly disagree
ITEMS	**FREQUENCY AND PERCENTAGE (%)**			
The school has sufficient maps (hard copies) for teaching and learning	09 (8%)	18 (17%)	58 (54%)	21 (19%)
I use 2-Dimensional maps to teach calculations and interpretation	30 (28%)	69 (65%)	05 (5%)	02 (2%)
I re-arrange the class into groups when teaching mapwork calculations and map interpretation	82 (77%)	15 (14%)	07 (7%)	02 (2%)
I allow the use of calculators when teaching mapwork	39 (37%)	61 (57%)	03 (3%)	03 (3%)
I allow the use of smartphones/mobile phones when teaching mapwork	11 (10%)	26 (24%)	59 (56%)	10 (9%)
I encourage discussion among learners when teaching mapwork	28 (26%)	52 (49%)	15 (14%)	11 (10%)
I exchange groups (swap group members) for each lesson on mapwork calculations and interpretation	24 (23%)	30 (28%)	40 (38%)	12 (11%)
My learners understand better when taught in groups	46 (43%)	28 (26%)	25 (24%)	07 (7%)
I assess learners on mapwork calculations and interpretation while they are seated in their groups	32 (30%)	54 (51%)	16 (15%)	04 (4%)

Theme 5: The Perception of Teachers with respect to Technological Knowledge (TK)

Participants answering the questionnaire narrated on their personal views regarding the use of technology in the teaching of mapwork calculations. The prompts were open-ended in that participants were expected to give their perception on both strands of prompt one and two. Prompt three required the participants to air their views on what they considered important to improve the teaching of mapwork calculations. Their views were analysed and coded following Braun & Clarke’s (2006) coding steps. Categories developed from the codes and ultimately resulted into seventeen themes. Table 6.2 on pages 178 -179 illustrates the distribution of the responses to the prompts in the questionnaire. One and three participants did not respond to prompts three and four, respectively.

Participants responded to twelve prompts about their perceptions of using technology to teach geography mapwork. A Likert scale with four alternatives, namely, *strongly agree, agree, disagree, strongly disagree*, was used. The prompts that participants responded to and the subsequent discussion of each prompt are given below. Prompts one to twelve are expressed as P1 to P12.

•P1 - Digital literacy in Geography teaching and learning is an imperative skill

The responses from participants indicated that 83% of geography teachers believed that digital literacy was an important skill in the teaching and learning of geography. Digital literacy was believed to be the panacea for all sorts of problems that ail the education sector (Arora, 2017). This is consistent with Padayachee's (2017, p.1) assertion that technology integration is viewed as "a panacea towards resolving South Africa's education challenges". In view of the resounding positive statements from numerous researchers about technology integration as facilitated by digital literacy of teachers and supported by data from this study, one may assume that teachers hold a similar perception about their digital literacy and the integration of technology in teaching geography mapwork calculations.

•P2 - Geography teachers should be trained to integrate technology in their daily teaching activities

There is strong belief that geography teachers must be trained on how to integrate technology in their teaching of the subject. All sampled teachers from the district share the view that teachers need to be trained to integrate technology in their teaching. It was apparent from the questionnaire responses which indicated 59% and 41% of *Strongly agree* and *Agree* responses respectively, with 0% for *Disagree/Strongly disagree* responses. It also emerged from the focus group data that teachers showed eagerness to be trained in the use of technology in their classes. As Ntombi from Focus Group 2 indicated,

> *We have been promised that the Department is going to invite us for the training but up to this day we're still waiting. Nothing has happened.*

It also was evident from the participant responses in Focus Group 2 that nothing had been done regarding teacher training in the use of technology. However, Jabu from Focus Group 1 indicated that even when they had to attend training sessions, only one teacher per school was invited and was expected to cascade information to other teachers. Newly appointed teachers and geography teachers belonging to the 'digital natives' were expected to assist older teachers in their technology lessons, as Tate from Focus Group 3 states,

> *On my side, there is nothing that I have seen, and no training has been offered to us. All I have heard of is that newly employed young teachers who are acquainted with technology must help older teachers with use of technology in class.*

Training was a much-needed engagement that geography teachers were looking forward to. Many researchers further proposed that "teachers should be offered training on the use of technology software, particularly on GIS, GPS and RS to avoid theoretical lessons with little application" (Kadhim, 2020, p.15) and how to integrate technology in teaching their subject lessons (Donnelly, McGarr and O'Reilly, 2011; DuFour and Reeves, 2016).

•P3 - Computer science training must be integrated into the geography national curriculum

According to Scheepers (2009, p.41), the "National Curriculum Statement regards geography as a subject which should contribute (amongst others) to enhancing learners´ ability to think critically and creatively". Computer science is an enabling tool that can assist teachers to effectively integrate technology into the national curriculum. The responses of participants indicated that 95% of the geography teachers believed that Computer Science (CS) should be integrated into the Geography curriculum. Webb et al., (2017, p.414) indicate that "the integration of Computer Science in the school curriculum rests on social, economic and cultural rationale". Economic rationale is viewed as "the need for a country to produce computer scientists to sustain the competitive edge as the world is driven by technology to support innovation and development". Social rationale emphasises "the value in society of a diverse active creators and producers rather than passive consumers of technology" (Webb et al., p. 415). Cultural rationale involves the idea that people should be enabled to be drivers of cultural change than having change imposed on them by technological development. Learners need not be passive users of technology but should lead, create and innovate within society using technology they learn at school. The same applies to geography learners, who must not only use technology, but must use it for further innovation. In addition, Webb et al. (2017) expressed the immediate broad potential benefits for learners learning Computer Science for thinking and problem solving, while benefitting teachers when providing feedback. It was apparent that the integration of Computer Science into the Geography curriculum had numerous benefits in transforming the teaching of the subject and enabled teachers to make good use of the technologies available to them. However, the integration goes with challenges in developing countries that are context-dependent (Johnson et al., 2016; Webb et al., (2017); Ontong & Khule, 2020).

P4 - Teachers need to expose learners to basic science and thinking innovatively from a young age

Responses indicated that 97% of the geography teachers believed that learners must be exposed to basic science and innovative thinking from a very young age. Only 3% of the participants did not respond to the prompt. Merriem-Webster and ISP at Uppsala University 2022 define basic science as any of the sciences including mathematics, anatomy, physics, chemistry, bacteriology, pathology, and so forth. These sciences are believed to “provide a fundamental understanding of natural phenomena and processes by which natural resources are transformed” (ISP, 2022). When learners are exposed to these subjects at a young age, they will potentially develop logical thinking which will assist them to master the subjects and technological process embedded in software programmes.

•P5 - Computers will only create more work for geography teachers

Responding to the prompt, 74% of the participants indicated that computers will not add more work for the teachers; only 26% of the responses indicated that computers would increase the workload. Eneriz (2019) revealed that technology integration into the classroom provides “an opportunity for deeper learning and more personalised learning for each student by making learning more relatable”. This is consistent with Ghavifekr & Rosdy’s (2015) view that technology equips teachers in their preparation for teaching with devices and that professionally developed teachers enhance the quality of their students’ learning. Teachers who have developed their technological and pedagogical content knowledge (TPACK) have the potential to assist their learners attain the learning outcomes (Philipsen, Tondeur & Zhu (2015); Graham, Borup & Smith, 2012). Koehler and Mishra, (2015, p.125) add that the TPACK framework may help to “provide the starting point for a conceptualisation and discussion of complex relationships in a methodological and grounded manner”. However, a number of research studies revealed that what teachers think they know or can do, their self- efficacy, does not necessarily align with what they really know or do in practice (Lawless and Pellegrino, 2007; Harris et al., 2010). Nonetheless, the relationship between self-efficacy and the practical behaviour of a teacher was shown to be a good predictor for the actual teacher behaviour in the Tschannen-Moran & Hoy (2001) study.

•P6 - Capable/experienced teachers do not need ICT to teach mapwork efficiently

Responses to the prompt indicated that 41% of the participants were of the view that experienced teachers do not need technology to teach mapwork efficiently, while 59% believed that even experienced teachers needed technology. It is important to note that schools that train their learners in outdated technologies are not meeting the needs of the day (Bindu, 2016).

Experienced teachers, no matter how capable they are, need technology to keep on par with the latest development of the 21st Century. The advent of the COVID-19 pandemic necessitated the upgrading of experienced teachers to new technologies to maintain communication with their colleagues and learners during the hard lockdown period. Bindu (2016, p.24) further asserts that technology "provides flexibility in education to ensure that learners are able to access knowledge anytime and from anywhere". The experience that teachers have accumulated over the years from their in-service teaching cannot maintain communication without the use of technological devices. However, they can utilise their experience to integrate new technologies with pedagogic flexibility to enhance the effective teaching of geography mapwork.

•P7 - Using technology can hinder my creativity skills in teaching geography mapwork

The responses indicated that 91% of the participants did not perceive the use of technology as an instrument that could negatively influence their creativity in the teaching of mapwork calculations. Only a minority of 9% believed that the use of technology would slow down their creativity skills. Page & Christian (2009) indicate that though the demand of using computer in teaching geography can be a daunting task, presenting glitches and frustrations, it certainly cannot substitute for quality teaching but can enhance quality teaching. Teachers in the sample believe that the use of computers can augment good quality teaching. Participants in Focus Groups 2 and 3 and from semi-structured interviews indicated support for the use of technology as an assistive software device rather than an impeding and frustrating venture. Ntombi from Focus Group 2 indicated that computers make the work easier, saying,

> *When teaching using technology, a teacher does not have to write everything on the chalkboard but prepares slides for presentation.*

This was further echoed by Ncane from Focus Group 3 who said,

> *Using technology has a positive benefit for both learners and educators because when traditional methods like textbooks and manual maps are used, they are easily torn apart, and they are insufficient at the same time. If we use electronic devices in the classrooms, it makes the work easier and faster for the teacher.*

It was apparent that many of the participants perceived the use of computers as assistive rather than diminishing their creativity skills. Ontong & Khule (2020, p.2) argue that "a stronger integration of technology (in the Geography curriculum) could enhance mapwork education in developing more relevant skills needed in the Fourth Industrial Revolution".

•P8 - Professional development regarding the use ICT in teaching geography mapwork is a waste of time

Responses indicated that 47% of the participants believed that professional development in technology integration was a waste of time while 53% disagreed. There was a degree of probability that their responses were influenced by the mediocre work of the Professional Learning Communities (PLCs) as a structure that was created to promote professional development of teachers. It was apparent in the focus group discussions that teachers lacked confidence in the PLC structures. Hhamu from Focus Group 2 indicated that he only heard of the workshops that were intended to train teachers in the integration of technology and was waiting for the invitation, but added that,

> *It doesn't look like we are going to get to the training in the foreseeable future. The department is always complaining about money. Things are becoming even more difficult regarding the integration.*

It was apparent from Zungama's comment in Focus Group 3 that the issue of technology integration was an emotional subject,

> *Now that the implementation is very slow on the part of the Department, we feel sorry that only 20% of schools, specifically the former Model C schools, is the only schools that manage to integrate technology effectively in their teaching and learning of every subject. We, who have always been public schools historically, we are not able to integrate technology in our teaching and learning.*

It was not thus surprising that 43% of the respondents to the questionnaire held similar perceptions when they responded to the question of technology integration as a waste of time.

•P9 - Knowing how to integrate technology in Geography is a worthwhile skill

The responses to this prompt indicated that 90% of the participants held the view that knowing how to integrate technology in Geography is a worthy skill. This is consistent with the view held by Stošić (2015, p.113) that "the application of educational technology enhances skills and cognitive characteristics". Knowing how and where to apply technology in teaching is important for geography learners as Shiny from focus Group 3 said that, *If they see things and look at the slides, they see its impact and its devastation effects, they never forget about that thing. To them it's just like playing a movie. They see even the heat waves in the ocean. They never forget about it, and as a teacher you feel at ease when planning for your lesson because you know it will capture your learners' attention.*

This confirms one interviewee's assertion in Şanlı, Sezer & Pınar's (2016) qualitative study in Turkey who claimed that when teaching Geography using digital technologies in the form of images and videos,

These become more permanent when you concretize them in order to show them that some of these things are the ones they see and experience in life. They both learn the subject better and forget later than usual".

It is, therefore, useful to have the ability to select a particular technology when teaching a certain theme in geography. The skills displayed by geography teachers in the research site bore testimony to this assertion. This is elucidated in the following section on observations at the research site (See Section 6.11 on page 199).

•P10 - Technologies are necessary to raise learners' interests and to encourage good performance in geography mapwork

The responses to this prompt indicated that 90% of the participants perceived technology to be raising interest in learners. While technology is expected to result in positive teaching and learning, Erkan's (2019) case study results indicated the opposite. This qualitative case study conducted in Turkey revealed that even when teachers and students have sufficient knowledge in the use of technology, successful learning cannot be assured. Despite this pessimism, many researchers were optimistic that technology could yield positive results if appropriately used for positive aims and when there were policies to guard against the misuse of the system (Kadhim, 2021; Nkomo, Daniel & Butson, 2021; ICASA, 2020; Eneriz, 2019); Kumaraswamy, 2018; Padayachee, 2017; Haßler et al. (2016).

Participants from focus groups indicated that technology raised the interest in learners.
Ntombi from Focus group 2 indicated that,

It's even more interesting for them if they have something like a tool.

Thandi from the same Focus Group also stated that,

> *They become more interested. I don't want to lie. Even if you make an example of their cell phones, like their profile picture, they become more interested.*

The level of interest increases among teachers as well. Sthabiso from Focus Group 3 indicated that,

> *When you have technology at your disposal, the level of lesson planning changes. You think of anything that can be of interest to your learners. You become more innovative in your teaching.*

It goes without saying that technology raises the level of interest in both teachers and learners when used for educational purposes. The interplay of UTAUT constructs could be perceived in technology raising interest in both teachers and learners. Performance expectancy and facilitating conditions in the school setting change the behavioural intention of teachers when using technology in class. At the same time, voluntariness as a UTAUT construct, based on social influences, affects the behavioural intentions of learners. Change in attitude also changes behaviour in using technology, moving away from socialising behaviour to learning new educational information and seeking more via the use of technology.

•P11 - <u>I feel tense and uncomfortable when using technology tools to teach geography mapwork</u>

The responses to this prompt indicated that 56% of the participants felt tense when using technology while 44% felt at ease. This could be attributed to the fact that most of the teachers had not been properly trained in integrating technology into their teaching. The effort they were expected to make when using technological devices influenced their behaviour in class. With the increase in the experience of using technology, teachers become more confident, and they use the system with ease. The interplay of effort expectancy and experience were perceived in the responses of participants.

David Nagel's (2018) survey results on learners from preschool to Grade 12 (K-12) using technology in the American schools indicated that 70% of the responses stated that cell phones caused tension and disruptions in the classroom. Due to the perception that some devices such as cell phones cause disruption, some schools confiscate them when found in the learners' possession. Despite the major contribution towards facilitating communication among teachers and learners, and assisting both to access educational information via internet, cell phones are still not acceptable as part of technology to be used in schools (Ngesi et al. 2018). However, tension and disruptions are likely to happen, and to avoid disturbances in using smartphones within a classroom environment, Anshari et al. (2017, p.15) suggest that "proper rules of using smartphones in class should be established before teaching, and students need to abide by the rules".

EMFSA (2021) indicates that computer science skills are at the centre of 4IR in South Africa, however, very few primary and high school learners had access to computers. The lack of access to computers has the potential to create tension in both teachers and learners in the classroom because when teachers present their lessons using computers, they are more likely to feel tense; so too will be the learners.

•P12 - Using ICT makes me more flexible and innovative in teaching geography mapwork

The responses indicated that 40% of the participants felt more flexible and innovative when using technology in teaching geography mapwork while 60% indicated the diverse. The majority of responses indicated negativity, probably because of a lack of confidence and knowledge of how to integrate technology into their teaching. Numerous factors combine to bring about a particular attitude towards the use of technology. Where teachers have been properly trained in technology integration, together with an effective infrastructure and school policies on technology integration made available and known to everybody, integration would more likely be effective. Flexibility and innovation are most certainly linked to several enabling factors in a school setting.

Table 6.2: Perceptions of teachers regarding the use of technological knowledge in Geography

LIKERT SCALE	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**	
ITEMS	**FREQUENCY AND PECENTAGE (%)**				**NO RESPONSE**
PROMPT 1	31 29%	57 54%	14 13%	04 4%	
PROMPT 2	63 59%	43 41%	00%	00%	
PROMPT 3	58 55%	42 40%	05 5%	00%	01
PROMPT 4	65 61%	38 36%	00%	00%	03
PROMPT 5	15 14%	13 12%	49 46%	29 27%	
PROMPT 6	15 14%	29 27%	55 52%	07 7%	
PROMPT 7	04 4%	05 5%	61 57%	36 34%	
PROMPT 8	16 15%	34 32%	48 45%	08 8%	
PROMPT 9	52	43	07	04	

	49%	41%	7%	4%	
PROMPT 10	56 53%	39 37%	07 7%	04 4%	
PROMPT 11	15 14%	44 42%	42 39%	05 5%	
PROMPT 12	18 17%	25 23%	58 55%	05 5%	

Table 6.2 presents the teachers' responses to the prompts as listed in the last section of the questionnaire, labelled as P1 to P12 above. All the prompts presented in Table 6.2 were discussed in the preceding text under Theme 5. Percentages were used instead of the actual numbers in the discussion.

Theme 6: The Open-Ended Questions

The questionnaire contained three open-ended prompts that the participants had to respond to. The prompts were as follows:

1. These are some of the issues that make geography teaching frustrating/enjoyable at times.
2. The integration of technology tools in Geography is made possible/hindered by the following.
3. This is important to improve the teaching of mapwork calculations.

6.7 Analysis of Theme 6

a. Prompt 1

The qualitative total responses to the first prompt were as follows:

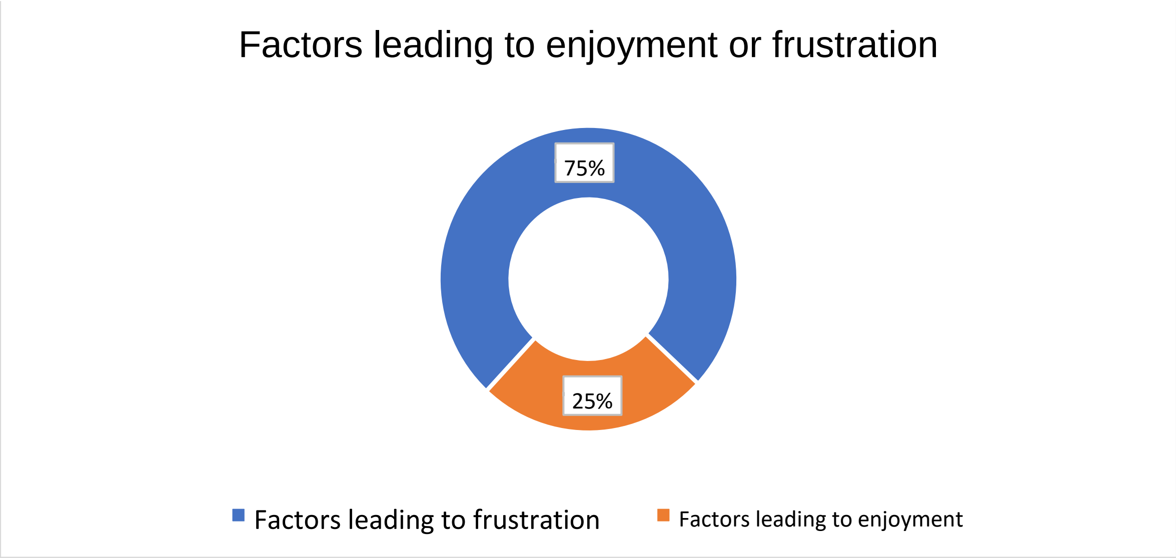


Figure 6.3: Factors leading to enjoyment /frustration in teaching Geography using technology

Figure 6.3 indicates that out of 106 participants responding to the questionnaire, the majority, which constituted 75% of the total responses, indicated dissatisfaction regarding the integration of technology in the teaching of geography mapwork calculations. They indicated that the problems they experienced led to frustrations while 25% of the responses indicated factors that led to enjoyment in teaching this aspect/theme.

b. Prompt 2

In response to the prompt as to what makes technology integration possible or what hinders integration, the participants responded as follows:

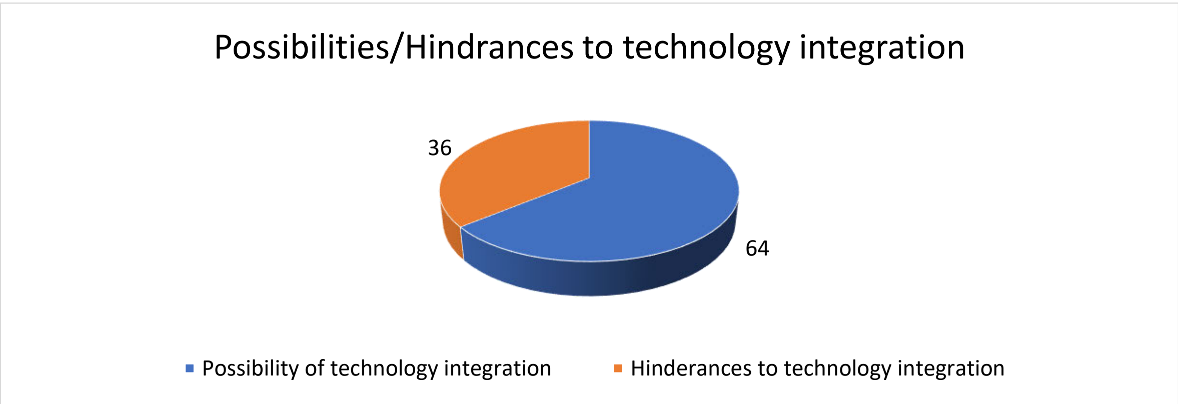


Fig. 6.4: Factors leading to possibilities or hindrances to technology integration in teaching geography mapwork calculations

Many of the responses to the prompt as to what makes it possible to integrate technology in the teaching of mapwork calculations constituted 64.1% against the responses to what hinders the integration, which constituted 35.9%.

c. Prompt 3

Responding to the prompt as to what is important to improve the teaching of mapwork calculations, the participants mentioned various propositions that could be grouped into seventeen themes. The themes developed from the propositions as responses to Prompt 3 are presented in Table 6.6 below. The figures in the table show the numbers of participants who proposed the strategy to improve the teaching in Mapwork calculations.

Table 6.3: Propositions on Prompt 3 by participants

PROPOSITION	NUMBER OF PROPOSERS	%
Training of teachers	36	34
Increasing pedagogic knowledge (PK) for teachers	72	68
Development of content knowledge (CK) for teachers	54	51
Creating cooperative learners	39	38
Provision of resources, e. g. devices, internet connection, etc.	81	76
Provision of access to technology by schools	47	44
Increasing learners' interest in mapwork	45	42
Developing more teaching strategies	77	73
Increasing the exercises in Mapwork calculations	84	79
Increasing the frequency of mapwork teaching	63	59
Increasing the number of projects and/or assignments in mapwork	87	82
Promoting English language fluency as the language of teaching and learning	23	22
Developing learners' mathematical skills	34	32
Organising more teacher exchange programmes	21	20
Planning for more group work activities	89	84
Organising extra classes	56	53
Purchasing good textbooks for learners	74	69

These themes are explained in the previous chapter. After conducting the focus group discussions, semi-structured interviews were conducted with participants from the research site. They were recorded using an audio-recorder and later transcribed. The researcher perused the interview transcripts repeatedly and developed the initial codes. Categories were established and themes developed from the categories and from the qualitative data from the focus groups and semi-structured interviews.

6.8 Analysis of Data from the Research Site (Night Owl Secondary School)

Mendelyan (2021) describes qualitative data as any form of non-numerical and unstructured data that are gathered, structured, and interpreted to understand what they represent. Qualitative data were solicited from participants at the research site. Two teachers who teach Geography to Grade 10 classes at the Night Owl Secondary School signed the letter of assent after the principal had provided a signed consent letter too. Face-to-face interviews could not be held due to COVID-19 restrictions, but an arrangement was made with the participants to conduct semi-structured interviews via WhatsApp. Individual interviews with the two participants were held separately, instead of dyadic interviews, although the participants were from the same school. A semi-structured interview schedule was followed to allow follow-up questions, where deemed necessary (see Appendix F). The researcher followed the same coding procedures and developed twelve themes from the semi-structured interview data with the participants. The participants were allocated pseudonyms to maintain anonymity and privacy.

Table 6.4: The biographical data of participants in the semi-structured interviews

Mpanza	MATRIC ✓	DIPLOMA	DEGREE✓	HONOURS ✓	MASTERS	PHD
Khumalo	MATRIC ✓	DIPLOMA	DEGREE✓	HONOURS	MASTERS	PHD

Professional training in geography teaching methodology

Mpanza	PGCE	DIPLOMA ✓	HDE	BED DEGREE	OTHER
Khumalo	PGCE	DIPLOMA ✓	HDE	BED DEGREE	OTHER

Employment status

Mpanza	PERMANENT ✓	TEMPORARY	SGB POST
Khumalo	PERMANENT ✓	TEMPORARY	SGB POST

Other subjects you teach

	SUBJECT	GRADE	SUBJECT	GRADE
Mpanza	Geography	11	Geography	12
Khumalo	Social Sciences	8	Social Sciences	9

Experience in teaching Geography?

	NO. OF YEARS	1 - 5	6 - 10	11 - 15	16 - 20	21 - 25	26 - 30
Mpanza	FET PHASE (Grades 10 – 12)					✓	
Khumalo	FET PHASE (Grades 10-12)		✓				

6.9 Analysis of Focus Group, Semi-Structured Interviews and Prompt 3 Data

Due to the qualitative nature of this study, it was deemed fit to analyse data from focus groups and semi-structured interviews simultaneously. The rationale for this analysis is that some of the themes that developed from the semi-structured interviews were like the themes developed from the focus group data and from Prompt 3 qualitative responses from the questionnaire. However, some of the themes from all these data collection methods were different. Table 6.7 below reflects themes that were similar in all three activities, and themes from each activity were discussed separately.

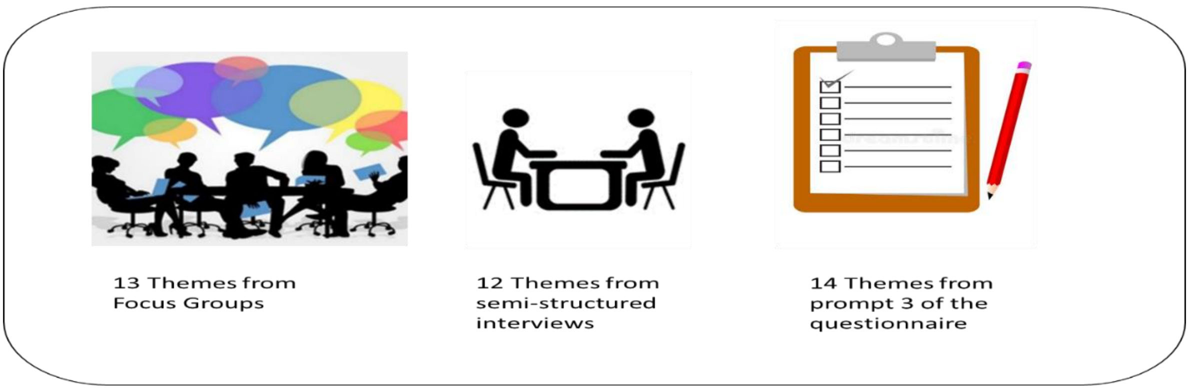


Figure 6.5: Qualitative methods used for data generation showing the number of themes

[Googlescholar images: *Naylor Association, Fotolia, and Dreamstime.com,* respectively]

The discussion of the themes follows the sequence as presented in Figure 6.5 above. Firstly, the themes from focus groups are discussed, followed by the discussion on the themes from the semi-structured interviews and lastly, the discussion on the themes from prompt 3 in the questionnaire. Some of the themes overlap, that is, they developed from two or more data sets from more than one method. Such themes are discussed in relation to the methods from which they developed.

6.10 Analysis of Qualitative Data from the Focus Groups

Three focus groups were conducted via WhatsApp, following the *Focus Group Guide* (Appendix 7). The discussions were recorded by means of a voice-recorder and later transcribed. The researcher perused all the transcripts repeatedly and identified the initial codes. The coding schedule was developed wherein all the extracts from the transcripts were presented. Reading through the coding schedule, the researcher identified relationships between the participants' quotes and developed categories. From the 130 codes that emerged from the three focus groups, twenty-two categories were developed. Through the data reduction process (coding), thirteen themes developed (refer to Section 5.3 in the previous chapter). The developed themes are:

- Support
- Policy on the use of Technology in Geography
- Resources
- Training workshops
- Interest in the use of Technology
- Benefits of using Technology
- Lack of Technology Integration
- Preferred technologies
- Unequal treatment of subjects
- Visualisation of geographic content
- Access to technology
- Enhanced Teaching and Learning
- Improved learner performance

NO.	THEMES FROM FOCUS GROUP (FG) DATA	THEMES FROM SEMI-STRUCTURED INTERVIEW (SSI) DATA	THEMES FROM QUESTIONNAIRE DATA (Prompt 3)
1.	Support	Pedagogic support & under-resourcing of public schools	Providing extra classes
2.	Policy on the use of technology in Geography	Latest developments in Geography	Developing mathematical skills & ESL
3.	Resources	Management of available physical resources	Availing resources
4.	Training workshops	Experience in marking standardised Geography examination papers	Training of teachers in the integration of technology/professional development
5.	Interest in the use of technology	Passion in teaching Geography	Cooperative learners & raising learners' interests in mapwork
6.	Benefits of using technology	Accuracy in measurement and data handling	Development of content knowledge (CK)
7.	Lack of technology integration	Tracking learners' work	Setting more group work activities
8.	Preferred technologies	Competences in Geography	Facilitating teacher exchange programmes
9.	Unequal treatment of subjects	Planning, teaching, assessing, recording and reporting	Increasing the frequency of mapwork teaching
10.	Visualisation of geographic content	Visualisation of the content & memory improvement	Technological Pedagogical Knowledge (TPK) of teachers
11.	Access to technology	Technology simplified description and explanation simple	Giving access to technology
12.	Enhanced Teaching and Learning	Quick marking and timeous feedback	Purchasing good textbooks
13.	Improved learner performance		Assigning more exercises on mapwork
14.			Assigning more projects/assignments on mapwork & developing assessment strategies

Figure 6.6: Themes that emerged from Focus Groups, Semi-Structured Interviews and Questionnaire data

Qualitative data from all three sources reveal convergence of ideas in relation to the themes that emerged after coding. The following themes are discussed and analysed below. Themes that emerged from semi-structured interviews (SSI) and prompt 3 from qualitative questionnaire that relate to the those from the focus groups are analysed together. Other themes are discussed separately as they stand alone, not related to those discussed below but are worthy to respond to the research questions.

- Support

The theme 'support' refers to all the infrastructure, development programmes, pedagogical assistance, policy reviews and resources such as technological devices and access to the internet. All the aspects that will facilitate the integration of technology in the teaching of geography mapwork calculations are necessary to realise the extent of the integration. All the participants expressed concerns about the lack of support in various ways. Internal structures in schools do provide minimum support, but are hindered by the policies that prohibit some of the initiatives that teachers take to improve the teaching of mapwork calculations. Provision of the necessary support that teachers seek will allow the integration of technology which, in turn, raises the interest in learners and improves memory that is likely to result in good performance in the summative assessments. Pedagogic support and programmes that are intended to increase the content knowledge (CK) of teachers form part of the support that is needed in school, as reiterated by participants in the semi-structured interviews. Support is not limited to teachers, but also includes the learners. The responses to the prompts (Section 3 of the questionnaire) revealed the need for extra classes to ensure that learners benefit from the use of technology in schools. Extra classes are believed to provide time to explore information that could not be accessed in the normal teaching and learning time. Dockstader (1999) stated that learners are motivated by technology to increase their time to engage with academic matters in their own time and space. Participants from focus groups and semi-structured interviews expressed their concerns about the support they receive to integrate technology in the teaching of Geography.

- Policies

Technology in schools takes on many forms and the use of smartphones to access information and to communicate with various levels of stakeholders has the potential to enhance the quality teaching and learning. The current state of school policies is said to hinder the use of technology in various aspects even though technology "has allowed easier, faster and cheaper access to information" (Western Cape Government, 2018, p.7). Regardless of the potential to assist in the teaching and learning process, "mobile phones are still disliked and outlawed in South African schools" (Ngesi et al. 2018, p.1; Burns & Santally, 2019, p.53). Policies in almost all public schools should allow the use of technology and not be selective regarding the type of technology to be used by both teachers and learners. Taylor (2020) indicates that technology had advanced and mobile phones have become essential gadgets in our lives. However, the banning of cell phones in schools minimises the chances of communication beyond school hours between teachers and students. The debate on the use of smartphones in schools is on-going despite the perceived practicality of the devices in education. Arguments around the distraction of learning in class and disruption of teaching and learning motivate some researchers to argue for the unbanning of the devices, but also quickly advise that learners be taught how to use the devices productively for educational purposes and provide the pros and cons concerning the use of smartphones in schools (Nulsen, 2020; Taylor, 2020; Brown; 2019; Ramey, 2019; Kowalski, 2016).

Participants in the focus groups expressed their concern with regards to the impact of policies in hindering the value expression of technology integration in schools. A lack of policy to facilitate the integration of technology in schools leads to the unequal treatment of subjects. Subjects that are deemed important and challenging are allocated more resources and more time than the rest. Participants from the focus groups revealed their concerns about science subjects being regarded as superior to other subjects and, consequently, benefitting from the perception of the school and departments authorities. Policies are meant to moderate the perceptions by allowing equal access to resources available in the school. Geography teachers must submit a request to the science teachers if they need to use some resources that were meant for the Science subject teaching, like the overhead projector, and others. Some geography teachers even resolve to bring along their own devices because of a lack of access to the resources that are meant for particular subjects. Furthermore, policies need to guide the school community against preferred technologies in schools. The school authorities, e.g., the SMT and the SGB, prefer certain technologies to be used by learners and not others despite, the perceived expediency of those technologies by the subject teachers. For example, cell phones are not allowed in schools as per policy, yet teachers need them to access certain software programmes that would facilitate their understanding of the phenomenon. The initiative of learners bringing their own devices to school for the learning of particular content does not apply to South African schools, particularly in the district where this research study took place.

Wisegate IT (2017) developed a *Sample Corporate Mobile Device Acceptable Use and Security Policy*, the document policy on the use of devices in schools to facilitate learning. The Horton Group Inc. further develop the Bring Your Own Device (BYOD) policy to provide security features for the devices, ranging from desktop computers, laptops, tablets, Personal Digital Assistants (PDAs), smartphones and portable music players, to ensure security of the devices in private and public institutions. However, Conway (2020) reveals that BYOD is an effective method that serves to improve and increase access to software on digital learning without purchasing the hardware (devices). Learners are expected to bring their own devices and the *Software2* programme is installed on their devices for educational purposes. Emmanuel (2014) recommends that technical and effective managerial packages for efficient BYOD implementation are required to cater for all aspects of connectivity in schools. Nonetheless, a pilot study conducted in June 2021 in South African schools concluded that "school leadership and management should continue to be exposed to projects that involve the use of digital technologies in the formal teaching and learning process" (van Greunen et al., 2021, p.16).

- Resources

The shortage of resources is common in many schools. Many of the participants expressed their concern about the uneasy integration of technology in their schools due to a lack of resources. Data from the questionnaire prompts revealed that teachers recommend that the KZN Department of Education together with its partners in provisioning ICTs in schools, should make resources available for successful integration. The same view was echoed by participants in the semi-structured interviews who expressed their concerns regarding the management of available resources. Participants from the Night Owl Secondary School work on the policy that all learners and their parents must sign a contract to return the textbooks issued to them at the beginning of the year. If a textbook is lost or damaged, the learner and the parents are liable for its replacement. In that way, textbooks are not purchased in bulk every year and the allocation for requisitions is used to purchase other materials and maintain technology equipment. The shortage of human resources was indicated in the focus group discussions. A shortage of learning space as indicated in the discussion, was evident during the observation sessions at the research site. Night Owl has an average of seventy learners in each class, hence congestion. However, despite the congestion, they manage to produce above average results, apparently due to the successful integration of technology in their teaching.

- Training workshops

Training of teachers on the integration of technology relies on the initiatives of the Department to organise professional development workshops and capacity development programmes. Participants reiterated their plight to become capacitated in the integration of technology to meet the challenges of the 21st Century. However, the invisibility of Professional Learning Committees (PLCs) and the unavailability of the Subject Advisor in the district present an insurmountable burden on geography teachers. Darling-Hammond et al., (2017, p.17) suggest that analysing the work of students, offers an opportunity for teachers to develop a common understanding of what good work really is, what common misunderstandings students have and what teaching strategies may be suitable, and for whom. The non-visibility of the PLCs or Geography cluster and the unavailability of the Subject Advisor in the district makes teachers' work difficult. Nevertheless, the use of the WhatsApp feature alleviates a considerable degree of pressure as they can communicate with one another and share important documents pertaining to the subject. It also emerged from the focus group discussions that some teachers use WhatsApp to communicate and assign work to their learners for extended learning at home.

A participant in the semi-structured interview, Mrs Mpanza (pseudonym), revealed that her experience in marking the standardised matric examination papers has increased her expertise. She knows how the paper is structured, and she is able to predict the type of questions that might be set for the examination. This helps to prepare learners to know how to respond to specific questions, providing accurate answers that will score marks in the examination.

- Interest in the use of technology

Technology is said to lend a fun element to learning through gaming and simplifies teachers' work. While using computer games to learn mapwork concepts such as continents and capital cities, rivers and mountains, and so forth, learners become enthusiastic and develop an interest in the use of technology rather than read two-dimensional maps in atlases. More interest in mapwork is developed as they observe three-dimensional physical features of the landscape through GoogleMap and videos. They develop map literacy and spatial cognition while engaging in gaming activities using digital technology, because map literacy and spatial cognition are “no longer confined to printed atlases” (Larangeira and van der Merwe, 2016, p.120).

To teach mapwork calculations using technology requires teachers with passion. A participant in the semi-structured interview, Mr Khumalo (pseudonym), indicated that teachers need to increase learners’ interest in mapwork and create cooperation among learners. Cooperative learners tend to assist each other in group work activities. When the teacher integrates technology into the teaching of mapwork calculations, learners are advantaged because they discover more tools to learn calculations. In all the lessons observed, there was a significant degree of integration of technological tools to explain the learning content.

A total of seven lesson were observed at the research site. A passion for the integration was evident in the lessons observed in Grades 10C and 10D classes at the Night Owl Secondary School. Figure 6.7 below shows the type of technology there was integrated in each lesson:

LESSON	TEACHER (Pseudonym)	TOPIC OF THE LESSON	RESOURCES AVAILABLE	HOW RESOURCES WERE USED
1	Mr Khumalo	Calculating True and Magnetic Bearing	Globe, Magnetic Compass, Topographical maps, Whiteboard and Screen projector	• Globe: used to explain Earth's rotation • MC: used to show how the compass needle changes to point at the Magnetic North away from the True North • Calculator: used to count following the steps to find Magnetic Declination
2	Mr s Mpanza	Measuring straight and curved distances	String; piece of paper; ruler; pair of dividers; Orthophoto and Topographical maps; network router; smart phones	• Piece of paper, ruler and dividers: used to locate actual route on a map • Pair of dividers: used to measure the steps along the string/paper in centimetres and millimetres • Orthophoto/Topographical map: used to locate distances to be measured by learners • Router: used to download GoogleMap distance calculator
3	Mr Khumalo	Speed, Distance and Time	Tennis ball; paper planes; stop-watch	• Tennis ball: used to bump it against the floor/wall and determine the distance •Paper planes: used to show how curved/ crooked distances delay time against straight distances •Stop-watch: to calculate time taken by t-ball to reach teacher's hand from the wall/floor
4	Mrs Mpanza	Calculating regular area	OHP; smartphones with map area calculator; router; whiteboard	• Whiteboard: used to write calculation steps and show conversions from cm to M and km • OHP: used for transparencies with the classwork • Smartphones & router: used to download area calculator
5	Mr Khumalo	Gradient	Road signs showing gradient; wall map on Physical Geography; Calculators; rulers. OHP; WB	Calculators: used to calculate gradient applying the formula: G=VI/HE Whiteboard: Used to show calculation steps Road signs: used to visualise what is used in the real world

6	Mr Khumalo	Calculating an irregular area	Orthophoto maps; calculators; Metre ruler; Whiteboard and Screen projector	Orthophoto maps: to show the demarcated areas to be calculated by learners Metre ruler: to draw a grid on which an irregular area would be laid out Whiteboard: to draw an irregular area on grid
7	Mrs Mpanza	Calculating differences in height	Wall maps and clay model with contours and beacons; OHP and Screen projector; calculators; video-clip	Clay model: to show how contour lines are arranged on the surface Topographical map: to show colours of contours, how sop heights, Trig. Beacons and benchmarks are represented on the map Video-clip: showing the physical world

Figure *6.7: Technology integration in the lessons observed at Night Owl Secondary School*

- Visualisation of the geographic content

Data from the focus groups discussions reveal that integration of technology in the teaching of mapwork calculations assist by making all the calculation steps visual to the learners. It begins with using GoogleMaps to display areas that need to be calculated or measured, technology practicalises abstract concepts. Participants in the focus groups affirmed that technology contributes to improving learner attainment in tests, projects, assignments and examinations, thereby improving the results. It familiarises learners with digital content that is necessary in the 21st Century. They further indicated that technology reinforces understanding through real life projections via the devices as opposed to traditional explanations and descriptions of abstract concepts. Participants in the semi-structured interviews revealed that planning with technology in mind invites innovation. Teachers become more innovative when they have technology at their disposal. While technology improves learner participation, it also reinforces memory, which is required during summative assessments.

Teachers at the Night Owl Secondary School have a passion in teaching geography mapwork calculations, as well as GIS. They make use of the limited technology that they have to clarify even the complex themes such as the layering of data, digitising traditional maps, converting satellite images to digital format, capturing data from stereo-pairs of aerial photographs and plotting information from a GPS device. Teaching these themes demand passion and interest in mapwork calculations and interpretations from a geography teacher.

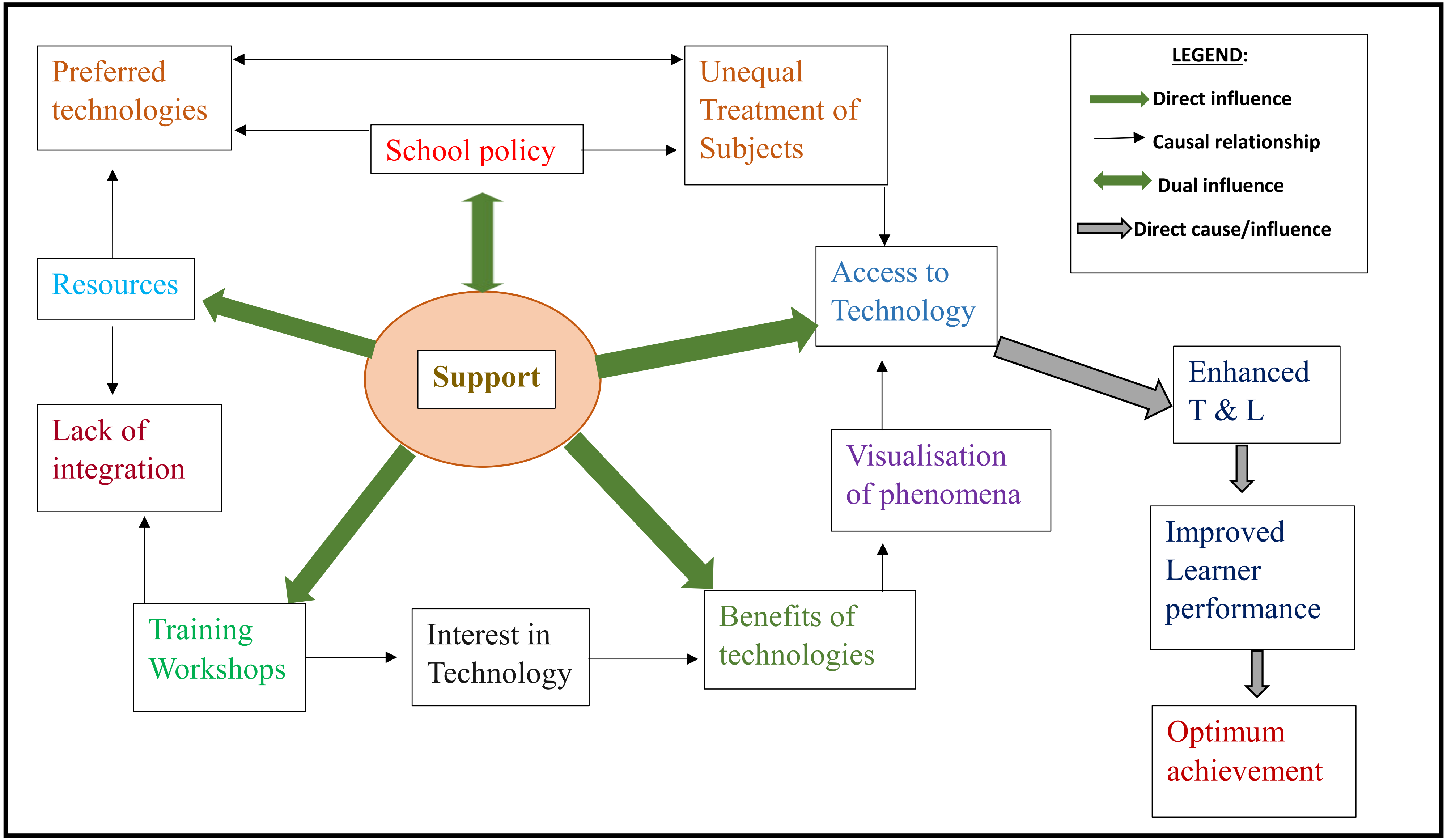


Figure 6.8: Technological Policy and Support in Geography (TePaSig Model) [Source: The researcher]

6.11 Operationalising the Model

• Support

Physical support in the form of resources, teachers trained in technology integration, technology infrastructure and devices are needed to facilitate the integration of technology in the teaching of geography map work calculations. Support entails some grounding from the school policy on the integration of technology in all activities within the school setting, from management and administration to classroom activities. Burns & Santally (2019, p47) suggest that "policy-makers should have a vision of the kind of teaching and learning they want to develop, as well as the knowledge and skills students should exhibit when they leave the secondary school system" Once formulated, the policy on the use of technology regulates access to technology for use by both teachers and students.

Davies & West (2013) argue that a digital divide is created by the unequal access to technology, impeding the social progress of some student groups as it negatively affects their institutions. Technology integration may be a top-down approach in some schools where school administrators and managers decide on the kind of technology teachers use in their teaching. Lynch (2020) argues that in such cases, the question of whether teachers use it effectively remains. He further argues that where teachers use technology regularly, there remains the question whether they are creating a teacher-centred or a student-centred virtual environment. The policy helps guide the activities of all school community members regarding the use of technology so that not only the preferred technologies that are compatible for use by some teachers are made available, while other forms are denied.

• Resources

Resources give rise to the effective use of technology and Bindu (2016, p.25) argues that "the application of technology is creating significant changes in the teaching and learning process". Tate, a participant in Focus Group 2, indicated that,

> *So much could be happening but hindered by the unavailability of resources.*

A lack of resources was further emphasised by Ncane from Focus Group 3, who revealed that,

> *all would be possible, but the problem will be the resources. Where are we going to get the resources? Again, our classrooms are small. That's why we rotate our classes, doing rotational teaching and learning.*

The issue of the availability of resources has been an ongoing topic of debate at various levels of society, from schools and non-governmental organisations to all the echelons of the bureaucracy. The issue of resources impacts negatively on the integration of technology while a lack of teacher training in this aspect exacerbates the matter. Untrained teachers in technology integration lack interest in technology as they do not know what resources to use and how to integrate those resources. Once teachers lack interest in using technology, they forfeit the benefit of using devices and internet connections. They cannot visualise their teaching content for the benefit of their learners. Lack of access to various technologies hinders the visualisation which is believed to reinforce memory in learners (Kadhim (2020); Basri, Alandejani & Almadani (2018); Bindu (2016). This was further emphasised by Mpintshi and Sthabiso from Focus Group 3, as well as Hhamu from Focus Group 2.

Access to technology is believed to enhance teaching and learning (Daniela, 2019). Access to technology allows teachers to make use of the devices and internet connection which, in turn, enhances the activities in class. Technology-enhanced teaching and learning encourage learner participation which leads to improved learner performance, thereby resulting in the optimum achievement in summative assessments. Figure 6.8 above illustrates the process and factors that impact on technology integration in schools, as impacted by policy and support, hence the name: *Technological Policy and Support in Geography (TePaSiG) Model.*

6.12 Themes from Prompt 3 of the Questionnaire

Data that was solicited from the prompts in the questionnaire produced seventeen themes, some of which have been incorporated in the discussion above. The remaining themes are expressed below:

- Setting additional group work activities

It became apparent from the questionnaire data that teachers need to set additional group work on calculations for their learners to become acquainted with mapwork calculations. Assigning more work on calculations will provide learners with an opportunity to internalise the formulae and the steps to be followed when calculating mapwork tasks using the scale. Data also revealed that more assignment and projects assigned to learners will generate more assessment strategies for geography teachers.

• Development of content and pedagogical knowledge for teachers

Professional Learning Committees (PLCs) and Geography Clusters need to assist teachers in developing both content knowledge (CK) and pedagogical knowledge (PK). Data from the questionnaire revealed that some teachers have difficulty in teaching mathematical operations involved in mapwork calculations because they do not possess sufficient content knowledge about mapwork operations. Some teachers did not study mathematics in the higher grades because of subject alignment in schools. When they are expected to impart knowledge involving calculations to their learners, they experience problems. This was highlighted in the 2018/2019 Diagnostic Reports of the Department of Basic Education (DBE, 2018; 2019). As a result, teachers who do not have sufficient content knowledge in mapwork calculations tend to avoid teaching this aspect of the subject or pay little attention to it. PLCs are expected to assist teachers by developing their mathematical skills as well as assisting them to master the language of teaching and learning. When teachers do not have a sound command of the language of teaching and learning they resort to code-switching with vernacular language, which hinders their learners in mastering abstract concepts, as they are not familiar with the terminology used in mapwork calculations.

• Facilitating teacher exchange programmes

Teacher exchanges as revealed in the data from focus groups would assist in developing the competences of those teachers who lack skills and knowledge of technology integration as they will be afforded an opportunity to observe teachers with particular expertise in the integration. This was clearly expressed in the curriculum reforms of the Dominican Republic education system with the introduction of technology in education (ICT4E). An ICT Professional Development Strategy for Educators in Dominica (2011, p.11) argues that "teacher professional development in the use of ICT is best introduced in a context of broader educational reform, which embraces a shift away from teacher-centred, lecture-based instruction toward student-centred, interactive, constructivist learning". Teachers in the sampled schools are cornerstone of curriculum reforms that necessitate the incorporation of technology in their teaching programmes.

• Increasing the frequency of teaching mapwork

Mapwork teaching is not afforded sufficient time, since teachers focus on other aspects in the annual teaching programme. However, it is evident that curriculum is loaded with many themes to deal with in a short space of time. This deprives learners of enough time to deal with mapwork calculations. It emerged from the questionnaire data that the majority of teachers only attend to mapwork calculations once a month while only 24% deal with it on a weekly basis. It is important to increase the frequency of attending to mapwork calculations to realise the potential of learners. Participants from the Night Owl Secondary School revealed that they incorporate mapwork in every theme they teach. This could increase learners' spatial literacy because Geography is based on mapwork, as Bednarz (2011) claims that maps are an indispensable part of Geography, as they form the informative core around which geographical data can be taught and learned. This is consistent with the assertion by Segara, Maryani & Supriana (2018) that map literacy skill is useful for daily activities and has the ability to improve learners' high order thinking skills. So, increasing the frequency of teaching mapwork skills is likely to improve learner performances.

• Purchasing good textbooks

It emerged from the focus group data that the textbooks purchased by the schools do not have sufficient information to assist teachers in teaching various aspects or themes. Teachers often resort to using three or more textbooks to find clearly expressed information and images to support learning. However, the DBE produces an annual list from which teachers must select the textbooks for their learners. Nonetheless, it emerged that some teachers prefer to purchase their own textbooks from booksellers to ensure that they have sufficient information and images that they can make copies of and supply to their learners.

6.13 Semi-Structured Interviews

Teachers use their smartphones, whether to seek information relating to their subjects from the search engines or from other teachers, as well as to send tasks to their learners using applications like WhatsApp. The option to use the WhatsApp application to facilitate communication is due to its ease of use and the social influence that the application has presented to the society in general. The WhatsApp application requires less effort from the user and it accommodates various functionalities such as text messages, images, audio- and video files, as well as stickers, emoticons and links to other web addresses (Bonsu, et al., 2020). The use of WhatsApp by teachers at the research site benefitted both geography teachers and learners as they were able to communicate even after school hours. Teachers were able to send online worksheets and assignments during the COVID-19 hard lockdown to maintain continuous teaching and learning. Both participants, Mr Khumalo and Mrs Mpanza were able to control the submissions made by learners and provide timeous feedback.

The use of technology at the Night Owl Secondary School is regulated by policy. From the interviews held with the participants, it was revealed that all classrooms have policies displayed on the walls. It was also witnessed during observations.

An interview schedule was used to conduct semi-structured interviews with the participants. (See the interview schedule in Appendix 8). Participants were asked to give a short bio of themselves, and each gave a synopsis of the history in the Night Owl Secondary School (See Table 6.4 on page 182-183).

The aim of conducting semi-structured interviews was to gain a deeper insight into the practices of geography teachers regarding technology integration in teaching mapwork calculations. As mentioned in (Newton, 2010) that semi-structured interviews allow individuals to disclose thoughts and feelings which are clearly private. Kvale & Brinkman (2009) add that this type of interview is conducted following an interview schedule that focuses on particular themes and may include suggested questions. Semi-structured interviews were used because they allow researchers to explore subjective viewpoints (Flick, 2009), and assist to solicit information about people's experiences. Lanteria (2021) describes semi-structured interviews as an interview where the interviewer or researcher asks open-ended or general questions to allow the conversation to flow freely and evolve independently. Cohen, Manion and Morrison (2007) further explain that semi-structured interviews lie at the centre of a continuum between structured on one end, and unstructured interviews on the other end.

While structured interviews are characterised by close-ended and pre-determined questions, with the interviewer following the same procedure for every respondent, unstructured interviews are the direct opposite (Lanteria, 2021). Unstructured interviews do not follow any procedure and comprise open-ended questions like an ordinary conversation where a particular topic is discussed. While structured interviews are highly standardised and follow "a rigid procedure of asking questions in a prescribed form and order", unstructured interviews "are characterised by flexibility of approach to questioning" (Kothari, 2004, p.98). Semi-structured interviews comprise pre-determined questions in the form of an interview guide but also preserve a degree of flexibility to ask follow-up questions, thereby offering an opportunity to solicit in-depth understanding from the interviewee about the phenomenon being studied. Salmons (2014) adds that semi-structured interviews balance the pre-planned questions of a structured approach with the spontaneity and flexibility of the unstructured interview.

Due to COVID-19 restrictions, face-to face interviews could not be conducted and were held using WhatsApp platform as per arrangement with the participants. However, in spite of all the positive cues that online interviews have with respect to geographic accessibility of participants, they do not "offer non-verbal cues like body language, gestures and facial expressions, which may give messages that help in understanding the verbal response that face-to-face interviews offer (Al Balushi, 2017, p.8). Consequently, the non-verbal cues were not perceived, which limited the kinesic communication with the participants. Kinesic communication is described by Salmons (2014, p.135) as communication that "includes eye contact and gaze, facial expressions, body movements, gestures and postures".

6.14 Themes from Semi-Structured Interviews

•Quick marking and timeous feedback

A participant in the semi-structured interview at the research site, Mrs Mpanza, advised that it is important for geography teachers to give tasks, projects and test but ensure that they mark the work in the possible minimum time available so as to provide feedback to learners. She indicated that,

> *Quick feedback is necessary for Grade 10 learners so that they know quite early where they went wrong because if you delay giving out feedback, they will stay with the wrong answers until they belied those answers are correct. So, it is advisable that once you complete marking, organise some time to give feedback when you return their scripts. I normally do so, and I have seen how it has helped me in reinforcing content knowledge in mapwork calculations.*

Feedback may even be provided using WhatsApp or SMS to encourage learners to attend to the identified errors as soon as they receive their marks. The participant reiterated that providing immediate feedback motivates learners to work conscientiously as they know that they will receive meaningful feedback, advising them on how to improve on what they obtained in a test or project. In response to the question about the importance of providing feedback to Grade 10 learners, Mr Khumalo argued that,

> *Feedback motivates them. They know exactly where they went wrong with the answers. So, giving quick feedback after marking helps erase all illusions they may have about calculations. Remember, most of the learners who selected Geography in the FET also do Maths Lit., which a bit different from algebraic operations. It is quite important to give feedback timeously. Even if you don't get time in class, ensure that you send feedback via WhatsApp so that they keep up with the work.*

Technology is said to assist from lesson planning, practical execution of the lesson in class, assessing what has been taught, recording the scores that learners attained from the test, assignment or project, right up to the reporting of achievements. This makes technology an indispensable tool in education. The participant in the semi-structured interview, Mrs Mpanza, affirmed that she uses technology in all the stages of her teaching.

> *I have all the necessary documents that I create myself. When I am planning work for the term, I create my own templates that I use. From planning, teaching, assessing, and recording, I use different templates that make my work even easier than writing on paper. I just keep all my templates in folders and keep updating them when necessary.*

She expressed her gratitude for the knowledge she received from the workshop she had attended four years ago, where she was introduced to technology by an organisation that partnered with the DBE in facilitating technology implementation in schools. However, such workshops have not been organised in the past three years.

- Tracking learners' work

Technology assists in tracking learners' work because all the records are kept in electronic folders that are easily portable, unlike physical files and mark-books that may be easily destroyed or lost. As long as the devices are safely stored, they remain available for easy reference. The participant also expressed her satisfaction in using technology due to easy access to a learner's file when needed. She stated that technology simplifies daily chores because she did not have to page a plethora of documents to find learner's records, and opening a folder did not consume much time. She argued that keeping a track record of learners motivated them as they know their performance is readily accessible to the teacher. In Geography, technology is believed to create a conducive atmosphere as learners come across new content on a daily basis.

6.15 Observations at the Night Owl Secondary School

Observation is one of the methods used to collect qualitative data from the research site, the Night Owl Secondary School. Prior arrangements were made with the participants. Both participants who teach Geography to Grade 10 classes offered their class timetables so that the researcher could arrange time in accordance with their lessons. Observations were held on geography mapwork teaching to see how teachers integrate technology into their lessons. The teaching period lasted for one hour. Seven lessons were alternately observed in two classes. The total class enrolment was 75 and 72 for grades 10C and 10D, respectively. The observed lessons were discussed in the theme: *Geographical skills and techniques*, under the following headings:

A. Calculating a regular area
B. Calculating the difference in height
C. Calculating straight and curved distances
D. Calculating irregular area
E. Calculating gradient
F. Calculating True and Magnetic North
G. Calculating speed, distance and time

Teachers use the language of teaching and learning throughout the lessons. One teacher stated during the interview that they use the language of teaching (LoT) to familiarise learners with the terminology used in the content.

Figure 6.7 on pages 191-192 presents the schedule of lessons that were observed at the Night Owl Secondary school. The teacher (pseudonym), the theme of the lesson, the resources that were available in the classroom, and the integration of the resources into the lesson are all present in the schedule. The observations were open, meaning that the units of observations were conscious that they were being observed. However, the researcher did not participate in the proceedings in class. The main objective of the observation was to determine how teachers integrate technology in their teaching of mapwork calculations and how they use words to elucidate calculation steps, that is, terminology as it relates to each theme.

6.16 Document Analysis

Document analysis was conducted in the research site, following the semi-structured interviews with the participants. Bowen (2009) describes document analysis as a procedure for systematically viewing or evaluating documents, both in printed and electronic materials. This is consistent with Wach's (2013) and Frey's (2018) definitions that it is a research method for vigorously and systematically analysing the contents of written documents. Frey (2018) reveals that this qualitative analysis is often used to triangulate the findings gathered from other data sources like the interviews or focus group transcripts, observations, surveys, and more. Documents were analysed after repeated reviews, examination, and interpretation of data. The documents that were analysed include the Annual Teaching Plan (ATP), teachers' seven lesson plans, teaching notes, learners' online worksheets, workbooks and materials used to facilitate class activities, assessment activities and related records such as the common tests records and their subsequent analysis.

- Annual Teaching Plan for Geography

The annual teaching plan (ATP) is the document proving guidelines on the implementation of the teaching content and strategies of teaching particular themes. The document also provides assessment strategies and assessment standards, as well as the reporting procedures to be followed after assessments are completed. Each subject offered in a school has a teaching plan for a year, which is aligned to the Curriculum and Assessment Policy Statements (CAPS). Geography is no exception.

The DBE resolved to amend the programme of teaching and learning to mitigate the impact of the COVID-19 pandemic on teaching and learning. According to Circular S11 dated 19 November 2020, the DBE adopted a multi-year curriculum recovery approach. This approach meant that the ATPs would be trimmed and reorganised to counter the disruptions to the teaching and learning process caused by the pandemic. Schools were provided with recovery ATPs that would be implemented over the period of three years, from 2021 to 2023. The vision of the revised curriculum recovery aimed to introduce and develop the Revised Modernised Curriculum Policy Statements (RMCPS) based on Section 4 of the CAPS and 2020 circulars.

Despite all the changes that the DBE effected in the system, no policy or regulation informs schools on how to integrate technology in teaching and learning to facilitate continuous engagement in teaching and learning. All the circular issued by the national and provincial departments did not address or regulate the integration of technology to mediate teaching and learning amidst the prevalence of the pandemic. The recovery ATPs only trimmed and reorganised the content in geography for the FET phase, without introducing or regulating the use of online teaching and learning, despite the ubiquity of technological devices among school communities.

• Lesson plans (Daily preparations)

Teachers at the research site used the lesson plan format common to all schools among geography teachers. It emerged from the interview with Mrs Mpanza that a geography lesson plan format was proposed by the Subject Coordinator in the district, because the Subject Advisor had not yet been appointed. The lesson plans were designed to follow all the steps of the lesson and included a section on the technology resources to be integrated in the lesson. This modification was an internal arrangement at the Night Owl Secondary School to promote technology integration in the lessons. The lesson plan format was designed to assist geography teachers to consider the resources they were going to use in their lesson, and how they would integrate technology into their lessons.

• Introduction phase

This phase of the lesson served as a formative inquiry as the teacher had to try and understand the learners' experiences and prior knowledge in relation to the topic. Using some form of creativity, the teachers would subtly introduce the goals of the lesson. Depending on the topic of the day, the teacher might introduce the lesson using a simple experiment, a quick quiz or a Q and A game. Creativity was expected to capture the learners' attention and raise their interest in the lesson.

• Teaching and learning phase

During this phase of the lesson, appropriate strategies were to be used to clarify the learning content and the teacher had to create opportunities for learners to enquire about their existing knowledge and apply new content knowledge. Depending on the classroom environment, learners were to be continuously given support and the new content consolidated. The teacher introduced the device to clarify the content and integrated the technology into the lesson while providing support in the use of the device. Feedback had to be continuously given to clarify the learning content or activities that learners were engaged in.

• Conclusion of the lesson

This phase of the lesson comprised homework and other follow-up activities. New knowledge would be summed up during this phase, which would determine whether the objectives of the lesson had been achieved. In addition, the teacher's content knowledge (CK) and pedagogic knowledge (PK) could be assessed in terms of successful presentation of the new subject content and proper use of teaching aids. The quality of classroom management could also be determined in relation to the teacher's attitude towards learners at this stage. The communication between the teacher and learners would be facilitated through appropriate strategies to reinforce the new learning content. This stage determined whether geography teachers were able to use the materials, methods and techniques according to the needs of the curriculum.

i. Lesson or teaching notes

Geography teachers issued notes on mapwork after they had taught the lessons. All the calculation steps were explained in the notes, together with examples for each calculation. The lesson notes were explicitly laid out and a few exercises were included for learners to keep practising the calculation steps. Lesson notes included the work that was assigned online via WhatsApp. This was revealed by Mr Khumalo during a pre-interview discussion. Lesson notes were concise and specific to each theme on mapwork.

Teachers also applied mapwork interpretations when teaching other themes in Geography. The application of mapwork in other themes assisted learners to develop spatial cognition as they could relate geographic phenomena to the specific locations where they occurred. Once given, learners were expected to safeguard their lecture notes in their portfolios.

ii. Online worksheets/activities on mapwork calculations

Online worksheets were provided at least fortnightly via WhatsApp. Teachers prepared their worksheets on their personal computers and forwarded them to learners. Learners were referred to *Geography worksheets and Online exercises* found at Geography worksheets and online exercises (liveworksheets.com). Reference was also made to FET Geography online notes and activities as presented by *Study & Master Support Pack* in line with the CAPS document. (Refer to: Geography Mapwork Worksheets - K12 Workbook).

Teachers assigned the online worksheets after a particular topic had been dealt with in class and determined the dates for submission of a specific exercise. Teachers provided feedback in class after marking the exercises.

iii. Grade 10 mark lists of tests and the examination schedule for 2021

Since Grade 10 class forms the basis for the FET phase education, Geography assumes a more scientific path in the curriculum. More complex calculations are presented, and geographic concepts assume a more complex and abstract level. The attainments of learners in the assessments also tend to vary significantly. The mark list that teachers presented indicated varying performances for Grade 10 learners. However, Mrs Mpanza indicated that their performance assumes a more common structure as they progress to the next grade. The final marks in Geography for 2021 of the two geography classes, Grades 10 C and C, indicated that learners obtained the following:

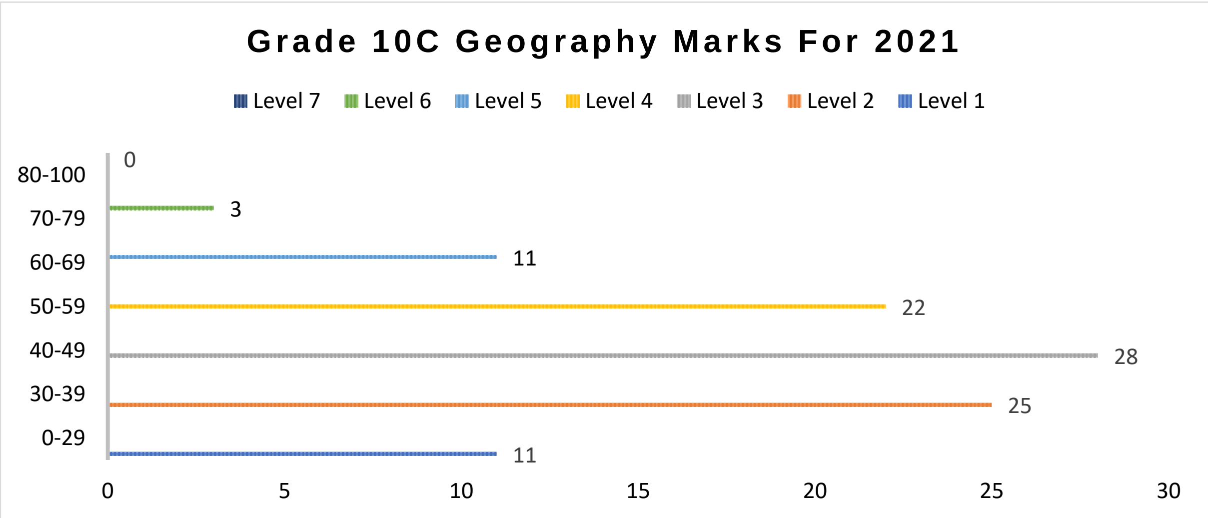


Figure 6.9: Geography marks for Grade 10C learners in 2021

The achievement of learners at the Night Owl Secondary School in Grade 10 shows that learners achieve more at levels 3 and 2. However, learners are expected to improve as they progress to the next grade. This is consistent with Mrs Mpanza's assertion that,

> *their performance improves with the grades as they get used to abstract and complex ideas and concept.*

An almost similar trend is evident in Grade 10D of the same school where learners obtained the following marks in geography in 2021.

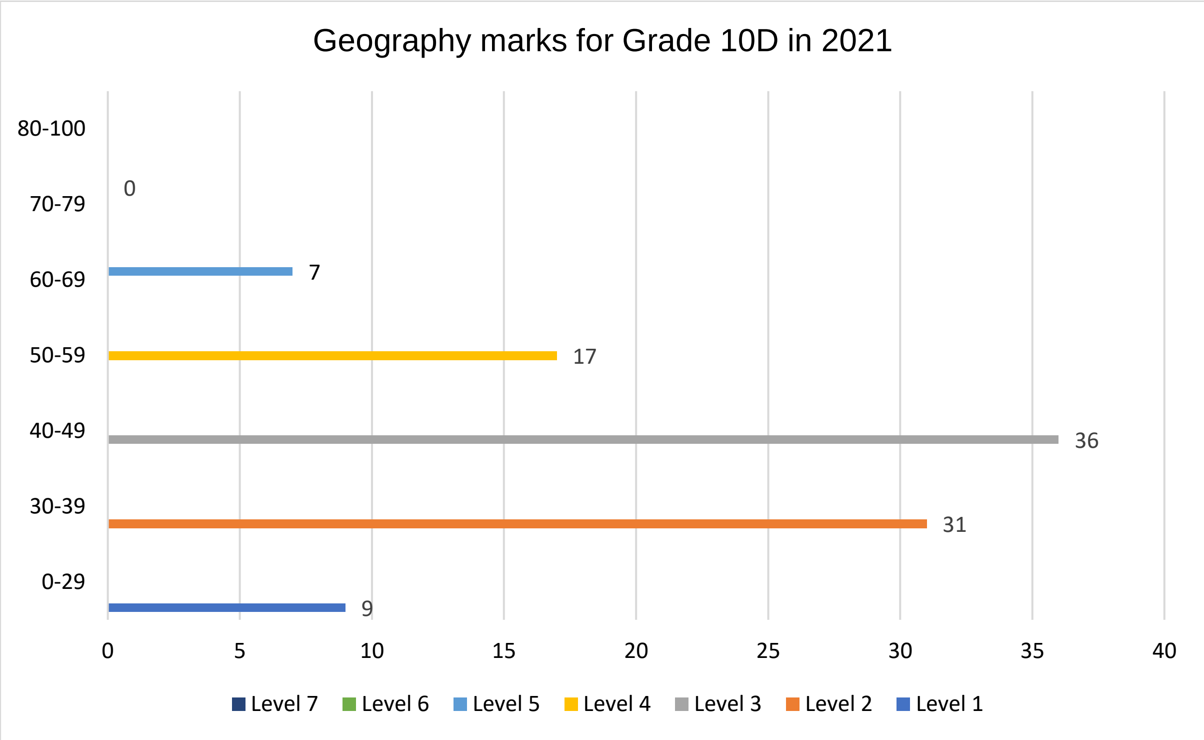


Figure 6.10: Geography marks for Grade 10D learners in 2021

The performance of learners in Grade 10C was higher than the performance of learners in Grade 10D. Nonetheless, the performance of both classes was expected to improve in later grades. It could not be justified that the experience of teachers had any impact on learner performances. However, the teaching experience of Mrs Mpanza who taught Geography to Grade 10C learners is almost twice as high than that of Mr Khumalo, who teaches Geography to Grade 10D. It was apparent from the interview data that Mrs Mpanza serves as a mentor to Mr Khumalo, who has almost half the experience of Mrs Mpanza in teaching the subject (Refer to Table 6.4 on page 180).

6.17 Operationalising the Geographic Technology Mentoring Model

Figure 6.11 below shows how facilitating conditions, as a construct of UTAUT, enable the experienced teacher to offer mentoring to inexperienced teacher/s. The school policy on the use of technology renders support and allows the acquisition of physical and human resources through teacher training. Policy influences the access to technology and raises interest, since nothing hinders technology implementation.

It could not be established whether an experienced teacher possesses more geography content knowledge (GCK) than an inexperienced teacher. However, due to classroom experiential knowledge (CEK), an experienced teacher manifests more capabilities in producing high achievement rates in terms of learner attainment. The experience that the seasoned teacher possesses, the knowledge and practice in how to integrate technology becomes normative in teaching geographical themes. The seasoned teacher imparts the skills and knowledge of technology integration to the less experienced teacher. This occurs in the form of mentoring. The technology integration knowledge (TIK) of the experienced teacher then enables the inexperienced teacher to teach learners using the devices at his/her disposal.

Mentoring of the inexperienced teacher is required in various aspects that pertain to the fraternity, like the management of the classroom, resources, teacher's files, time and teacher's work in general. The experienced teacher mentors the inexperienced teacher in policy development, the use of online teaching and other forms of online platforms. The inexperienced teacher possesses unqualified technological knowledge (UTK) and classroom inexperience (CI), as well as Geography content knowledge (GCK) and limited Geography pedagogic knowledge (GPK). Giving feedback, either written or verbal, to learners also requires some professional skills. Once the inexperienced teacher has received adequate coaching and mentoring, she or he will develop expertise in using the technology that is available in the school setting. The expertise that an inexperienced teacher has, will be utilised for the benefit of geography learners, and will enhance teaching and learning in the classroom.

The environment in which technology-enhanced teaching and learning (TETL) promotes maximum participation of learners throughout the learning experience, allows teachers to use their pedagogic knowledge and technological skills to impart content knowledge to the learners. This, in turn, leads to improved mapwork calculations in a geography class. The improvement in using technology allows learners to search for more subject-related information which brings about optimum achievement during assessment.

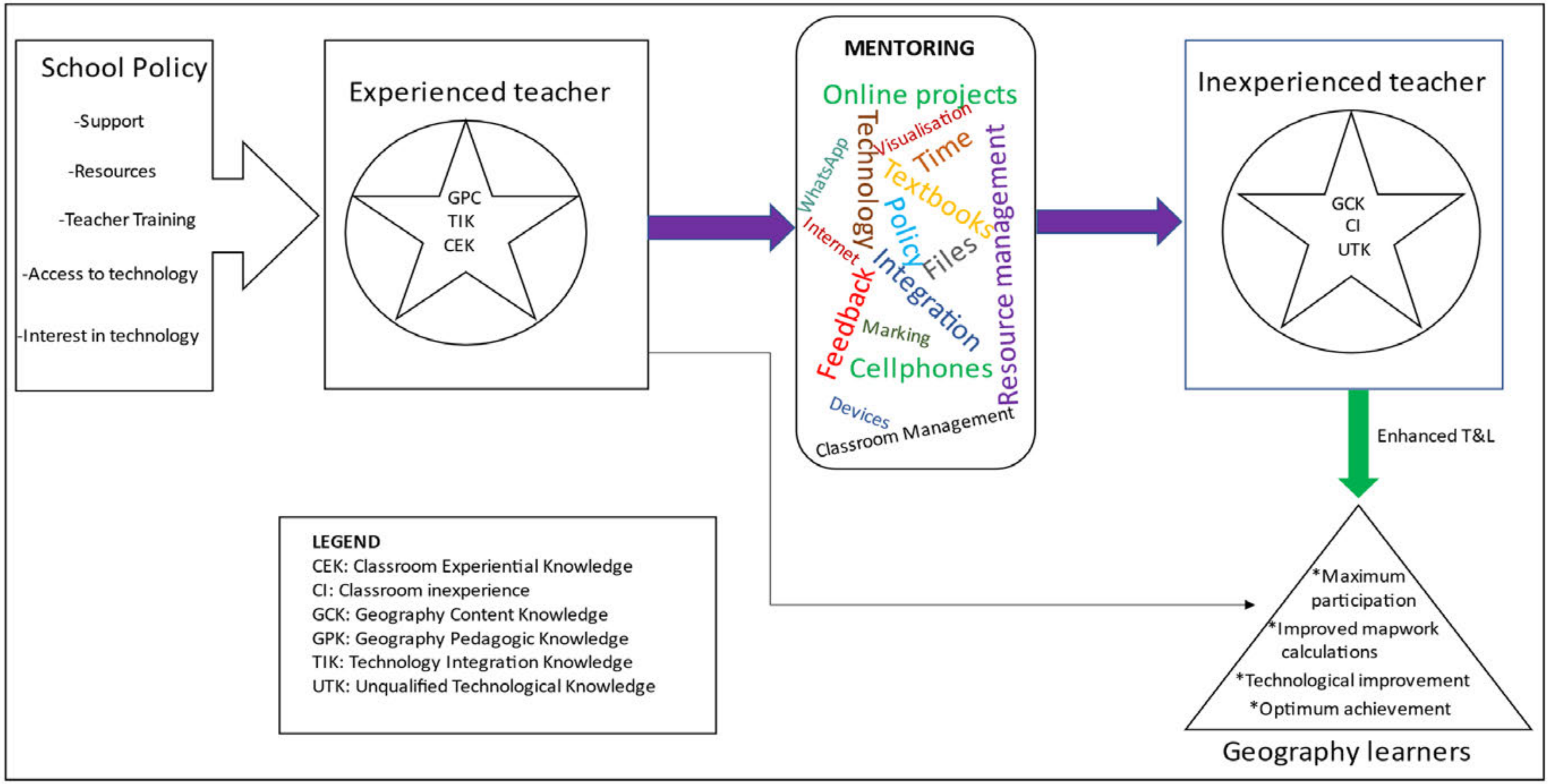


Figure 6.11: Geographic Technology Mentoring (GTM) Model [Source: the researcher]

The use of the Geographic Technology Mentoring (GTM) Model will assist both experienced and inexperienced teachers during the mentoring process. This model in Figure 6.11 emanates from the researcher's experience at the research site, perceiving the interaction between the experienced teacher and the inexperienced teacher. The analysis of the model is the researcher's view on the interaction between geography teachers.

6.18 Conclusion

The research analysed various data sets as they developed from data collected by means of focus groups, semi-structured interviews, observations, document analysis and qualitative questionnaires. Qualitative means of expressing the analyses have been used in the form of figures and tables. Different themes emerged during the analysis and both descriptive and evaluative analyses were employed, with reference to the two models, the Unified Theory of Acceptance and Use of Technology (UTAUT) and the Technological Pedagogic Content Knowledge (TPACK). The interpretations and findings of the analysis are presented in next Chapter 7.

CHAPTER 7

THEORISING ON EMERGENT THEMES, CONTRIBUTING TO

THE SOCIAL CAPITAL

7.1 Orientation to the chapter

This chapter discusses the findings from the data collected from participants in schools within the district and the research site, using various data collection methods. Conceptual models, namely, the Unified Theory of Acceptance and Use of Technology (UTAUT) and the Technological and Pedagogical Content Knowledge (TPACK) were used as theoretical lenses to frame the study along the constructs of the models. The use of the constructs assisted the researcher to analyse the themes that emerged from the gathered qualitative data. Themes were presented in Chapter 5 and analysed in Chapter 6. In this chapter, the findings will be discussed and interpreted.

7.2 Synthesis

The review of literature and the analyses of data obtained through qualitative questionnaires, from focus groups and semi-structured interviews at the research site, as well as data collected through observations and document analysis, resulted in numerous themes on which the findings were based. The findings were discussed in the previous chapter and the subsequent conclusions are expressed below. The data gathered by means of various qualitative data generation methods contribute to a clear assessment of the extent of technology integration in the teaching of geography mapwork calculations in schools within the selected district in KwaZulu-Natal. The summary of the findings and the interpretation thereof is provided below.

7.3 Summary of the Findings

The term ‘integration’ is different from the term ‘using’ in their operation. Koehler and Mishra (2005) assert that ‘using’ technology means the utilisation of activities such as PowerPoint presentation, slides, web sites and more, that can impart information to learners. In ‘using’ technology, learner interaction is negligible or none, and no interactive participation by learners takes place in the teaching and learning environment. Alternatively, ‘integration’ entails active participation by learners using interactive software programmes and websites that enable learners to understand the subject content knowledge (Sanli, Sezer & Pinar, 2016). This study focused on the integration of technology and not merely the use thereof, which keep learners passive in all learning activities. The interactive engagement with technology becomes social capital.

The research activity that was undertaken aimed at obtaining an understanding of the phenomenon based on the following objectives:

- *To explore how teachers use technology to teach mapwork calculations in Grade 10 Geography education.*
- *To find the reasons why teachers use the methods they do in the teaching of mapwork calculations.*

7.3.1 Discussion of the Findings from the Qualitative Questionnaire

The qualitative questionnaire entailed responses based on the five themes listed below:

- *School context in relation to technology integration.*
- *Teacher's personal expertise regarding the use of technological devices and software*
- *Teacher's personal experience in integrating technology into the teaching of Geography*
- *Implications of technology in the teaching of geography mapwork*
- *Teacher's perceptions with respect to technological knowledge (TK)*

Theorising on Theme 1

As reflected in Figure 6.1 (page 166), 63% of geography teachers in the sample did not have computers of their own. However, they managed to communicate with their learners, using Smartphones and other devices. This is confirmed in Figure 6.2 which indicates that 92% of Grade 10 teachers in the sample possessed smartphones. It thus can be concluded that the sampled teachers could integrate technology in their teaching by assigning worksheets and projects to learners using Smartphones. Even though 49% of schools did not have internet connection, as reflected in Figure 6.3 on page 180, only 16% of Grade 10 geography teachers who had personal connectivity to the internet could make use of the resources they were able to access, and share them with their colleagues on their Smartphones. The frequency distribution of schools with computer laboratories, as reflected in Table 6.1 on page 169, illustrates that geography teachers are not entitled to use laboratory facilities to teach geography mapwork calculations. However, the 30% of the teachers who had access to the science laboratory could use the resources to integrate technology in their classrooms. Since 89% of sampled schools had overhead projectors available for use, it was apparent that the OHPs were the primary resource that geography teachers could use to integrate technology in their lessons. However, as differentiated above in section 7.2, learners could not interactively engage with OHPs, as only teachers who led the discussions could use the OHPs to elucidate the calculation steps and to display maps on the whiteboard, using the device. This condition limited the depth and extent of the integration in geography classes.

As reflected in Figure 6.5 on page 183, many schools in the district did not have subject committees. This condition culminated in schools not being able to run professional development workshops on site to assist teachers with technology integration. It was apparent that there were no clear programmes related to the professional development of teachers, as there were no structures available to facilitate professional development (PD) programmes except the School Management Teams (SMTs). However, it could not be established whether there was any significant integration of technology in the 25% of schools with available subject committees.

Theorising on Theme 2

As reflected in Table 6.2 on pages 178-179, 50% of geography teachers were able to use Word Processing while 40% had little expertise in the Excel programme. Teachers with internet browsing skills were significantly higher, compared to those without. However, only a few of the sampled teachers had programming skills, while the difference in the use of PowerPoint was significantly less. The expertise of downloading resources for geography teaching was significantly higher, which coincided with the skills in internet browsing. The expertise of designing lesson plans using technology was marginal. While several computer programmes require internet connection, some of the software programmes do not require connectivity. The computer software package could be used at any time without frustrations caused by the lack of connectivity. It is believed that exposure to the use of various computer programmes should enable teachers to make use of their computer literacy skills to develop teaching materials that suit their lessons, without relying on connectivity.

Theorising on Theme 3

As reflected in Figure 6.6 on page 185, many teachers could not prepare their lessons with a view of integrating technology; their responses indicated that they had difficulty in finding useful resources on the internet. In addition, the sampled teachers could not use the internet to support their teaching and did not know where technology was applicable to their lessons. These challenges indicated the need for training and mentorship. Figure 6.6 reveals that the experiences of teachers regarding preparation and presentation of their lessons entailed a more rigorous training in the use of technology tools to enable them to integrate technology effectively into their teaching.

Geography teachers indicated that their ability to use technology to monitor the progress of learners in terms of recording the marks was efficient. Their inability to use technology to support learning was best illustrated when using TPACK and UTAUT as analytical frameworks to assess teachers' technological knowledge and pedagogical expertise in integrating technology to teach mapwork calculations. Performance expectancy, as the construct of the UTAUT, played a significant role in influencing teachers to use the Excel programme to record learners' marks. Effort expectancy also played a significant role in teachers using less effort to understand how the Excel programme worked. The degree of ease influenced them to rely on the programme to record marks and calculate percentages thereof. Since marks were expected to be recorded without errors and in legible form, most of the teachers in different schools used the Excel programme to record and submit the learners' scores. Social influence also placed a measure of force on teachers to use the programme.

The technological knowledge (TK) that teachers had with respect to the use of the Excel programme was influential in recording learners' test and examination marks. Though only 25% of the teachers indicated that their expertise in using the Excel programme was poor, it was apparent that most teachers with average to excellent expertise were able to assist their colleagues in using the programme.

Although not all teachers used PowerPoint to effectively present their lessons, 88% of the responses indicated average to excellent use of the programme. It was apparent that most teachers could present their lessons effectively using the programme if other facilitating conditions were in place in their classrooms.

In using technology to communicate and share teaching resources like documents with other teachers, 97% of the responses indicated that teachers were able to use the WhatsApp application. The expertise in using this application was significantly higher than those who could not use the application. It could be concluded that teachers used the WhatsApp application to communicate and share documents among themselves. However, some of the teachers used the application to share and communicate with their learners too. This was indicated in the focus groups and semi-structured interviews.

As reflected in Figure 6.4 on page 180, 64 percent of the responses indicated that teachers could use technological devices. However, facilitating conditions in their schools would not allow them to do so. The lack of technology infrastructure and an internet connection remained problematic in most schools.

Theorising on Theme 4

As reflected in Table 6.3 on page 181, 73% of the schools did not have sufficient copies of maps, while 93% had two-dimensional maps which they used in teaching mapwork calculations. In explaining this finding, it can be stated that most teachers relied on traditional methods of teaching mapwork using two-dimensional maps due to a lack of technological tools to view the landscape three-dimensionally. The arrangement of classes into groups held several benefits for both teachers and learners. Teachers with insufficient maps could allow their learners to share the available maps to accommodate every learner, while learners could share their understanding of the tasks as they were allowed to discuss the work in their groups.

A significant degree of technology integration was apparent, where 94% of the teachers in the sample allowed their learners to use calculators. However, only 34% allowed learners to use smartphones and/or mobile phones. This was ascribed to the school policy on mobile phones which did not allow learners to use this device on the school premises. Maphalala & Nzama (2014, p.461) indicated that "some schools had completely banned the use of cell phones within their premises due to security concerns and the distractions that resulted from their inappropriate use". However, most schools in the district had no formal policy on the use of cell phones at school. This was common in many of South Africa's provinces except for the Western Cape which had already introduced *Guidelines on Cellular Phones and Other Mobile Technologies in Public Schools, 2018*. While the National Association of School Governing Bodies (NASGB) called for a ban on children using cell phones at South Africa's schools in 2012, some schools had eased the restrictions for use in certain subjects under the strict guidance of a teacher. In addition, the DBE issued a statement, after a leak of the NSC

Mathematics Paper 2 and Physical Science Paper 2 occurred in 2020, that “all candidates will be required to complete the Electronic Devices’ Register, which will be managed by the school” (Gwegwe, 2021, p.3). The regulation stated that once a learner was alleged to have leaked or was found in possession of a leaked examination paper prior to the writing of that examination, s/he would be required to submit his or her cell phone or any other electronic device to the Department for further investigation. It was apparent that the unbanning of the use of cell phones and other electronic devices within school premises had far-reaching consequences due to inappropriate use relating to cheating in examinations and cyberbullying. This impacted negatively on the integration of technology in the teaching of subjects, particularly, on geography mapwork. In this regard, Maphalala & Nzama (2014) proposed that policies needed to be strengthened and stern action be taken against transgressing learners. This was further supported by Ncube (2017, p.85) who suggested that “systems should be put in place to ensure internet safety for the learners who are vulnerable to illicit consumption of bad stuff from the internet”. He further proposed the creation of filters to keep out materials that are deemed anti-social and psychologically damaging to learners. In the face of the COVID-19 pandemic, Ramrathan (2021) argues that schools need to shift the focus from “education for all” to “education for relevance”. This entails a redirection of focus from traditional methods of teaching and learning to match the demands of the 4IR to overcome the challenges presented by the pandemic to South African schools. Policy reviews regarding the use of technology in teaching and learning, particularly, mobile phones, form part of the shift to “education for relevance”. Geography mapwork calculations in schools form part of this policy review to accommodate the use of various technological devices and software applications that will facilitate learners’ understanding of calculation steps to obtain correct and precise answers to questions on this aspect.

Theorising on Theme 5

As indicated in Table 6.2 on pages 178-179, 83% of the responses revealed that teachers believed digital literacy was an important skill in geography teaching and learning. In addition, 95% of the responses indicated that teachers believed that Computer Science (CS) training should be integrated into the Geography national curriculum. This prompt has strong links to the teachers’ practices in their classroom, as the CS training would facilitate a deeper understanding of the computer’s value and promote skills in digital literacy. Digital literacy and computer science training could have an enormous impact in quelling the condition of uncertainty when integrating technology in the classroom. This condition was identified by Padayachee (2017, p.57) who concluded that "while teachers do show enthusiasm, they also show uncertainty regarding how to proceed with ICT integration in the classroom". The effectiveness of technology integration in teaching was initially emphasised by Ghavifekr & Rosdy (2015) who indicated that it would help teachers to replace traditional teaching methods the universal with a technology-based teaching and learning tool and facilities as a 21st Century requirement. It is apparent that the teachers' belief in the importance of technology integration did not bring about scepticism, as the Focus Group 2 participant, Hhamu, also indicated that,

> *most of the learners fail to understand the question on GIS because it requires the use of technology to facilitate understanding of the themes in question'*, and that '*GIS is more practical*.

Similar sentiments were echoed by the Focus Group 3 participant, Sthabiso, that

> *It becomes easier for them rather than using the traditional ways of teaching where a learner only imagines things, but now, technology makes it easier because everything is displayed.*

The training of geography teachers was a major concern to teachers as they felt that without training, there was little or nothing they could offer regarding the use of technology in the classroom. The entire sample indicated that geography teachers should be trained to integrate technology into their daily teaching activities. In addition, 99% of the responses indicated that teachers believed that learners should be exposed to basic science and innovative thinking from a young age. Early exposure to basic science improves the opportunity to work with improved visuals, animations and videos. Chimmalgi, Jose & Kumari's (2017, p.3405) study concluded that while boys were more technologically literate compared to girls, "their familiarity with technology did not translate into better performance with e-learning". This conclusion assists teachers to apply technology in their teaching without reservations to the learner population in the classroom.

As indicated in Table 6.4, 74% of the responses indicated that teachers did not perceive the use of computers as additional work. According to the UTAUT, the experience in using computers, tablets, smartphones, and other technological devices lessens the effort to integrate technology in the teaching and learning programmes in the classroom as teachers become familiar with a variety of applications. Since access to technology using computers and mobile phones by teachers and the public has grown exponentially throughout South Africa (Vota, 2021), such utility motivates geography teachers to use a variety of devices in their teaching of the subject. Furthermore, the experience of teachers in using devices facilitates the conditions in schools where a greater probability of implementation of technology resources is likely when such resources can be used productively to benefit the school communities. Consequently, most teachers did not feel pressurised into using computers to facilitate integration into the classroom.

As indicated in Table 6.4, 59% of the responses from participants indicated that most teachers believed that the experienced or capable teachers, too, needed technology to teach mapwork efficiently. Himmelsbach (2021) argues that technological knowledge of teachers empowers educators and increases student engagement to create innovative learning experiences in and outside the classroom. However, this does not result in effective teaching and learning, argue Ghavifekr & Rosdy (2015); Voogt & McKenny (2017). Although twenty-eight of the thirty research studies conducted to determine whether teaching experience contributes to effectiveness found positive and significant association between the two, (Kini & Podolsky, 2016), argues that technology integration in teaching was not found to yield positive results with growing experience. This significantly leads to the conclusion that even experienced and capable geography teachers need technological proficiency to teach mapwork calculations efficiently.

Table 6.4 reflects again that 91% of the responses revealed that teachers did not believe that technology negatively affected their creative abilities when teaching geography mapwork calculations. This perception is consistent with Friedman's (2019, p.1) assertion that "teachers who use technology in transformative ways and focus on creativity in learning increase the number of students who are able to engage in problem solving". Findings from an online survey which involved 1 035 K-12 teachers, conducted from March to April 2019 revealed that technology does not slow down creativity but, instead, boosts the creative abilities of teachers by 53% for teachers working in supportive environments (Friedman, 2019).

As reflected in Table 6.4, there was no significant difference between positive and negative responses to the question of professional development of teachers regarding technology integration into the subject. There was a high degree of probability that some of the teachers perceived professional development as a waste of time. This is due to a lack of supportive infrastructure in schools and unfavourable policies that hinder the integration in the classroom.

However, a larger percentage of teachers still believed that professional development is necessary to capacitate teachers with technology integration skills despite a lack of resources. It was more likely that those teachers were optimistic about future engagement and initiatives that the DBE was trying to pursue to meet the goals of Sustainable Development. In addition, the attitudes of teachers towards the integration of technology in the classroom varied. Sutar, Bhosale & Pujar (2019) indicated that many observations reveal that some teachers do not have intelligibility about the extent to which technology can be beneficial for facilitation and enhancement of learning due to a lack of competency to manage issues of integration while other teachers may have positive attitudes to the integration of technology in their teaching.

As indicated in Table 6.4 on pages 1182-183, 90% of the responses reflected the perception that the use of technology raises the interest of learners and encourages improved performance of learners in mapwork. This is consistent with Petrovic's perception that "digital tools and websites can also serve for stimulating students' vivid minds and improving their academic and social skills" (Petrovic, 2021, p.5). The positivity of teachers rests on the assumption that TPACK is indispensable to teachers who want to develop their teaching skills through the application of technological tools and software programmes in the classroom context. This is further entrenched in Davies & West's (2014) statement that TPACK is the knowledge that teachers need to teach their specific content area effectively and successfully with content specific technologies. In Geography, there are a variety of technological tools and software programmes that teachers can use to effectively present the geographic content and guide their learners to access more data that relate to specific concepts and problem-solving techniques in mapwork. Such technologies raise interest as learners are enabled to solve their geographic problems using technologies, thereby making it easy for them to apply all the steps in mapwork calculations.

As reflected in Table 6.4, almost half of the responses indicated that teachers felt uneasy when using technology in their classroom. This is more likely to have emanated from a lack of professional development in technology integration and poor infrastructure in schools. It was further supported by the EMFSA (2021) that schools lack basic infrastructure that could assist to alleviate the tension that teachers experience.

Sixty percent of the responses indicated that teachers did not feel more flexible and innovative in teaching geography mapwork. There was a high degree of probability that a lack of access to resources, coupled with poor integration skills and knowledge, were causing scepticism which resulted in teachers becoming inflexible and lacking innovative skills in their teaching. In the same vein, Owston (2018) asserts that teacher development lies at the heart of sustaining an innovation. Flexibility in teaching is intertwined with flexible learning. Joan (2013) describes flexible learning as referring to those who are interested in different way of learning namely, e-learning, m-learning and online learning. In this sense, learners have a choice about where, when and how learning takes place. Teachers with the capacity to assist their learners in technology adoption become more innovative and flexible in their instruction to accommodate different learning choices.

Theorising on Theme 6: Open-Ended Questions

Frustrations regarding technology integration in the teaching of geography mapwork calculations superseded factors that led to enjoyment in teaching this aspect. As reflected in Figure 6.3 on page 180, 75% of the responses indicated a negative perception of geography teachers. The repertoire of factors mentioned in the previous discussion, namely the lack of resources, inconsistent professional development initiatives, policies on technology integration and access to technology in schools, among others, are significant impediments to promoting technology integration in the teaching of the subject, particularly, in mapwork calculations.

Responses from geography teachers indicated that there were more factors that could facilitate the possibility of technology integration than there were hindrances. Table 6.3 on page 181 summarises the responses that participants proposed to be facilitating factors that could promote technology integration. According to the UTAUT, facilitating conditions influence the behavioural intentions of technology users, thereby changing their attitude which, in turn, leads to the use of the devices (Wibowo, 2019). Teachers are more likely to apply new strategies involving new technology in their teaching, based on their change of attitude towards integration, depending on the nature of the facilitating conditions in their school contexts.

7.4 Discussion of the Findings from the Focus Groups Interview Discussions

As indicated in all focus groups, a lack of support from the internal structures in schools, namely, the School Management Teams (SMTs), School Governing Bodies (SGBs) and Subject Committees (SCs), caused a slow integration of technology while in some schools it caused a total neglect of technology integration. SGBs are expected to ensure that the schools are protected from vandalism, which leads to theft. Once schools lack security, it encourages vandalism, and technological devices become popular targets of vandalism. Munje & Jita (2020) reveal that the nationwide occurrence of vandalism and theft of technology equipment during lockdown necessitated by the COVID-19 pandemic were mainly due to lack of security in schools. In view of this assertion, it is apparent that inefficient functioning of SGBs indirectly contributed to slow or non-integration of technology as teachers could not facilitate the integration where devices had been stolen. However, this condition could not be solely attributed to the malfunctioning of SGBs but was also exacerbated by the lockdown imposed across the country during the pandemic (Ngqakamba 2020; Mbuza, 2020; Maromo, 2020). Support from the SGBs will always be vital in securing school property, particularly costly technology devices, to assist integration in the classroom.

SMTs have a crucial role to play in assisting teachers integrate technology in their classrooms. SMTs with clear programmes for professional teacher development are in a better position to realise the attainment of a school's vision and aspired learning outcomes. Although the availability and integration of technology should not be a yardstick for measuring learner performance, its impact on learner motivation and increased aspirations to learn cannot be ignored (Jimenez, 2020; Santos et al., 2019).

As illustrated in Figure 6.4, School Subject Committees are legitimate structures in the DBE and every school needs to establish one. The presence of these structures ensures proper planning and implementation of professional development activities within a school. Their function, among others, include addressing the "limited access to quality continuous professional development (CPD) opportunities for teachers and a weakness in the system to achieve dramatic improvement in the quality of teaching and learning in schools". Participants in the focus groups indicated that these structures were non-existent in their school. Where they existed, they had very little or no impact in alleviating problems experienced by teachers regarding the integration of technology and professional development in general.

Furthermore, SMTs were expected to address some of the challenges regarding the acquisition of relevant resources and provide tangible programmes regarding the strategies for the integration of technology in the classroom. While SMTs were supportive in some schools, other participants revealed that they did not receive sufficient support from their SMTs. External structures include district, circuit, and subject cluster committees. Cluster committees found to be existent in the district, were under scrutiny and did not function as expected because of the absence of the Subject Advisor. The volunteering Subject Coordinator could only provide minimal support to geography teachers as he had limited or no access to all the resources that teachers needed to function effectively. The Subject Coordinator could not organise workshops for teacher development as he himself was at a school level where he was expected to be present and work on a full-time basis. The limited time available to the coordinator was used for moderation and addressing few issues about the subject. Nonetheless, geography teachers in the district were able to communicate among themselves and share documents and expertise where they encountered specific problems. Collaboration of teachers in cluster schools also helped them to manage instructional activities and developed teacher exchange programmes to share their expertise.

7.5 Discussion of the Findings from Observations

Observations at the Night Owl Secondary School created a clear understanding of what technology integration entailed. The two geography teachers who presented their lessons on mapwork calculations during observation, demonstrated a high degree of technology integration into the teaching of mapwork calculations. Seven lessons were observed in two classes at different times.

The use of various resources available in the classroom facilitated the efficient presentation of a lesson. In specific lessons that required the use of mobile phones, learners brought their own into the classroom while the teacher provided other devices such as the magnetic compasses, clay-models, road signs, a tennis ball, router, orthophoto and topographical maps. Other items such as the OHP, whiteboard and projector were already installed in the classroom. Even though mobile phones were not permitted for use by learners in the school, geography teachers had made special arrangements with their respective Heads of Department for Humanities for the use of them.

While teachers were presenting their lessons, they made a smooth transition from actualising prior knowledge in the introduction to the presentation of new knowledge in the teaching and learning phase. Appropriate teaching strategies allowed the proper use of available teaching aids to be incorporated into the lesson, while continuous consolidation of the new content was maintained. Timeous feedback was given to learners to ensure they followed all the calculations steps involved in the lesson. Lessons were clearly summarised as stated, objectives were reached, as they formed the basis of the planned lessons.

7.6 Discussion of the Findings from Document Analysis

The teachers' documents were scrutinised, which revealed the successful integration of technology in various lessons. The documents analysed included the Annual Teaching Plans, teaching notes, online worksheets, learners' workbooks and assessment activities together with the relevant records.

Although there were some modifications made to the ATP for Geography due to the multi-year curriculum recovery initiatives that the Department implemented in the FET phase, themes on mapwork calculations were not affected in the new streaming of the content. As indicated in the previous chapter, the DBE did not introduce or propose new regulatory strategies concerning the use of mobile devices in teaching and learning amid the advent of the COVID-19 pandemic. Teachers used their own discretions and devised strategies on how to proceed with their daily tasks, as they were expected to report to schools on gazetted dates. The uncertain situation in which teachers found themselves in most schools did not adversely affect Night Owl Secondary School as they had a policy on the integration of technology in place.

Lesson notes that teachers provided their learners were clear and explanatory, giving examples on how to navigate the calculation steps in mapwork. Online worksheets were descriptive, and learners could understand what was expected of them in accomplishing the tasks set out for them.

The mark lists and the schedules were well prepared, showing the analysis of what learners attained in the tests, projects and in the examination. Despite the overcrowding in the classroom, learner attainment in various activities was not adversely affected. However, the attainment increased with the grades. Learners in Grades 11 and 12 performed better than those in Grade 10. Teachers justified these performances as mainly caused by the fact that learners were not used to the highly scientific structures of the geography curriculum, as Geography was becoming more insulated from history in the FET phase.

As indicated in Figures 6.9 and 6.10 on pages 206 and 207, respectively, learner attainment assumed a bell-shaped structure with more learners achieving between Level 2 and 4 in the year mark. According to the teachers at the research site, this structure was expected to change as learners proceeded to the next grade. However, that could not be disputed as the school performance had constantly maintained a hundred percent pass rate at Matric level over the past ten years, although this study focused on the last five years of performance in Geography.

7.7 Factors affecting the Integration of Technology in the Teaching of Mapwork Calculations

Despite teachers at the research site and in other schools within the district mentioning various factors causing slow or non-integration of technology in their teaching, Night Owl Secondary School managed a significant level of integration. This did not imply that the school solely relied on the integration of technology to produce good results, but the integration of technology in the lessons raised learners' interest in the subject and motivated them to do their utmost in completing the tasks. However, Joan (2013) concludes that to develop their interest and make their learning easy and effective, students should equip themselves with profound knowledge of technology.

Apart from several hindrances that prevent integration from occurring in schools such as lack of resources, professional development workshops, unequal treatment of subjects, school policies and many others, the concept of technology integration entails a strong understanding of the technology and the approach to online teaching structures (Owston, 2018; Joan, 2013). Furthermore, Owston (2018) views the school principal as another essential factor that contributes to sustainability in a school. It takes a reasonable and competent leader of an institution to provide enabling conditions for new initiatives to thrive under adverse circumstances within the extensive technology plexus.

7.8 Analysis of the Social Capital in Technology Integration

The adoption of technology for teaching geography mapwork depended on what teachers perceived as important in their praxis. Once adopted, the integration of technology in the teaching of mapwork becomes a social capital of the group of teachers who use technology in their teaching praxis. Bartkus & Davis (2009, p.2) define social capital as "a representation of the resources that arise from relationships and which could assist individuals and the collective to reach their goals in working towards the common good". The common good in the relationships among geography teachers is the use of technology in their teaching of Geography. Perceptions on the integration of technology in geography teaching promotes cohesion between the members of the community of geography teachers as they share their expertise and resources to achieve the common good, namely, the attainment of learning outcomes by learners. Arriaza & Rocha (2016) view social capital as the worthiness embedded in relationships. These relationships are important in the teaching arena as they facilitate the possibility of efficiency in the work of geography teachers.

Though ‘capital’ is viewed as a medium of exchange in economics and commerce in capitalist societies, Downing (2011, p.19) defines it as “the source of benefit or assistance”, while Rogošić & Baranović (2016, p.86) view capital as “the resources contained in social relations”. In these views, teachers act jointly, using the resources (technology tools, expertise, and knowledge), thus creating trust as the building blocks of social capital. Trust in this enterprise of teaching geography mapwork using technology is the sense that members of the community of practice are conducting their relationships in good faith and no individual teacher will act solely out of self-interest. Fafchamps (2004) argues that trust should be understood as an optimistic expectation or belief regarding other agent’s behaviour. Bound by social cohesion, each member of the community bears responsibility for every other member of the community of practice. Darlauf & Fafchamps (2005) assert that leadership and trust are essential for the delivery of the public good. A capable leader is required to convince community members that they should voluntarily contribute to the attainment of learning outcomes in education. Trust is necessary to resolve conflicts among competing interests of members of the group. Both leadership and trust are necessary prerequisites for the beneficial integration of technology in a school setting and in the classroom. Norms and expectations are created based on trust and good leadership, and they are both facilitated by networking. Networking enables bridging and bonding, as linkages in the relationships between and among members of the groups of teachers are established.

This leads to reciprocity, where every member feels obliged to return favours and services that have been offered from the group. The reciprocity of services and resource provisions among members of the group, i.e., community of practice made up of geography teachers in the vicinity or district, is based on networking as the necessary condition in bringing about human association or social interaction. This voluntary association known as ‘networking’ is defined as a system of linkages with other members of the community on whom one can rely. (Coleman, 1990; Bartkus & Davis, 2009). The linkages form a network of connections between members of the groups in the community and among members within each group. Linking social capital refers to relationships between people at different hierarchical levels. Figure 7.1 below presents social capital with the related constructs leading to the integration of technology in a school setting.

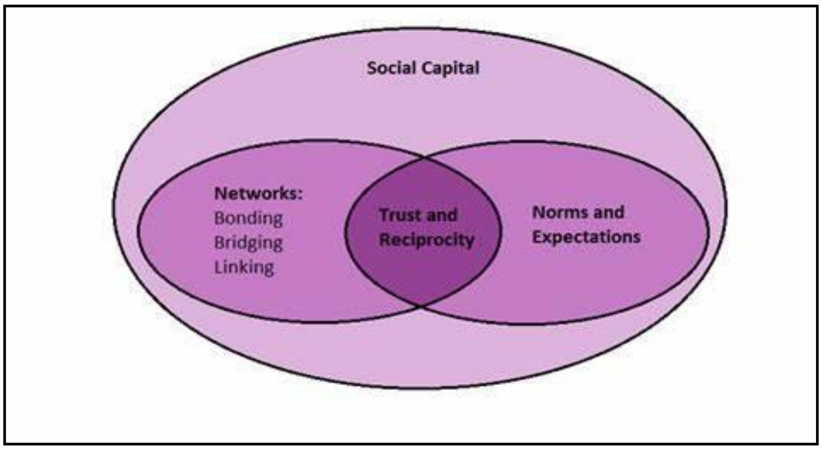


Figure 7.1: Social capital and its tenets leading to technology integration in geography Teaching [Adapted from Google: hl250-socialcapitaltheory.weebly.com]

The theory of social capital was first developed by Pierre Bourdieu and James Coleman who examined the effects of social capital in education. Despite this theory being a long-standing model in social sciences, it only entered academic and policy debates in the late twentieth century (Bhandari & Yasunobu, 2009). According to the World Bank (2004), social capital rests on two conceptual views. Proponents of the first view include sociologists like Ronald Burt, Nan Lin & Alejandro Portes, who view social capital as resources that individuals are able to procure from their relationships with other people. Such resources include information, ideas and support. The second approach is held by Robert Putnam, a political scientist who views social capital as the nature and extent of involvement in various informal networks and formal civic organisations. These approaches are somewhat, related, in the sense that both rely on the relationships between individuals and groups to accrue a measure of necessities to achieve a groups' common goal.

7.9 Operationalising the Model for Technology-Enhanced Geography Mapwork Teaching

In pursuit of technology integration, geography teachers are confronted by external drivers that influence them to integrated technology in their teaching of the subject. Such integration may vary in relation to factors affecting the level of integration. These external drivers include extrinsic motivation, social factors, support, price, mandatory use (of technology), ease-of-use and the context of the school environment. Definitions of each of these drivers (both external and internal) are given in Table 3.1 in Chapter 3. These external drivers are internalised by geography teachers through perceptions (transmission channels) and impact differently on teachers (individual differences), thus influencing change in behaviour.

Once internalised, the external drivers become internal drivers and influence the teacher to conduct pre-use evaluation of the technology at their disposal. The ease-of-use of the type of technology promotes habits in individual teachers who feel confident using the type of technology available. Teachers become intrinsically motivated to continue using technology in their praxis (behavioural intentions) and may even develop the scope of integration by exploring other types of technology tools for further and advanced integration (technology-use behaviour). After conducting post-use evaluation, teachers feel more confident and develop norms of practice and expect other teachers in their group (community of practice) to adopt and integrate technology in their practice too.

The relationships between teachers sharing the common good of assisting learners to perform optimally in the classroom and, subsequently, in the assessments, motivates them to communicate their practices and share the teaching resources (capital) that each has in their possession. They communicate through meetings, professional development workshops, exchange programmes and use common social media channels (communicative measures) such as WhatsApp, Facebook, emails, and more. Such communication builds up trust and is facilitated by strong leadership, as explained in section 7.4 above.

Professional development workshops are the result of the inner urge to distribute knowledge, skills and expertise of teachers who have more experience in integrating technology in their teaching. In-service training sessions may be deemed important to fast-track the process of technology integration. Online courses on the integration of technology may be an option for the less acquainted, while mentoring on-site may be more effective in facilitating the integration process, as it was the case at the Night Owl Secondary School. Connectivity plays a vital role in the transmission of expertise, skills and resources (capital) among the group of teachers. Putnam (2000) suggests two types of social capital, i.e., ‘bonding social capital’ and ‘bridging social capital’ as forms of linkages among groups of actors in the community of practice. Sharing strengthens bonding and bridging among the groups of geography teachers. Bonding happens when a group creates social capital within itself, and between its members. It denotes the construction of social relationships between persons in similar situations, thereby building strong ties bound by trust and leadership. Bonding assumes a horizontal networking of members of the group (community of practice) (Arriaza & Rocha, 2016; Putnam, 2009).

Claridge (2018, p.3) defines bonding as "the networks with a high density of relationships between members of a group where individuals are interconnected because they are acquaintances and frequently act collaboratively". Geography teachers assume the same position as they should meet frequently in professional workshops, cluster meetings and online via social media. Bonding promotes strong relationships between members of a team through shared experiences, and brings about more efficiency in practice as members become specialists in their work.

Bridging on the other hand, is where teams create social capital to achieve the same goal. Bridging social capital assumes vertical networking of relationships between structures at different echelons within the department, which create relationships to infuse ideas with the sole aim of achieving the desired outcomes. In education, departmental officials and other stakeholders create relationships with teachers to share ideas, skills and expertise regarding the integration of technology in geography teaching. The vertical relationships in bridging social capital are more impersonal than the horizontal relationships in bonding social capital. As teams in upper echelons of the bureaucracy create relationships with teams in the lower echelons, vertical bridging occurs, and becomes more successful as both teams share common interests and goals.

However, Boyce (2022, p.1) argues that relationships in bridging social capital are not as strong as they are in bonding social capital because "the links come from weaker connections, and the connection is bridged through an intermediary". The vertical relationships in bridging are not established through trust between members of the same group but the element of power exist between groups located in bureaucratic structures. Claridge (2018) argues that in vertical bridging, the issue of power is important between heterogeneous groups despite sharing common interests and goals to achieve the common good. It becomes the norm that the powerful group in the higher echelon is expected to provide resources (capital) for the group in the lower echelon, thereby facilitating the attainment of shared goals, the learning outcomes. Through horizontal bonding and vertical bridging, both the community of practice (geography teachers) and department officials create relationships based on networking and provisioning respectively, to enhance technology integration in the teaching of geography mapwork in a school context.

Figure 7.2 on page 230 below illustrates the relationships between external and internal drivers as facilitated through transmission channels and internalised by the community of practice (geography teachers). Communicative measures assist in facilitating the attainment of social capital (technology integration) through professional development (PD) workshops, in-service training, online courses and mentoring, as it happens in a school context. The internet connectivity is vital in facilitating communication within and between groups in the community of practice. Members within the groups in the system communicate among themselves (horizontal bonding), sharing geography knowledge, expertise and resources in the form of documents (electronic and physical). Departmental officials and partners in education (stakeholders) communicate with geography teachers (vertical bonding) in an attempt to empower the latter to achieve the common good (learner achievement)

Through networking between groups forming the community of practice, enhancement in the teaching of Geography becomes possible. In addition, provisioning of technology resources in the form of technology infrastructure and internet connectivity in schools (facilitating conditions) enables enhancement in the teaching of geography, particularly mapwork calculation. The model for Technology -Enhanced Geography Mapwork Teaching (TEGMT model) attempts to theorise the conditions, factors and actors within the education system with the aim to facilitate the enhancement of quality geography mapwork teaching using technology to achieve the ultimate goal, namely, the attainment of the learning outcomes in Geography for the FET.

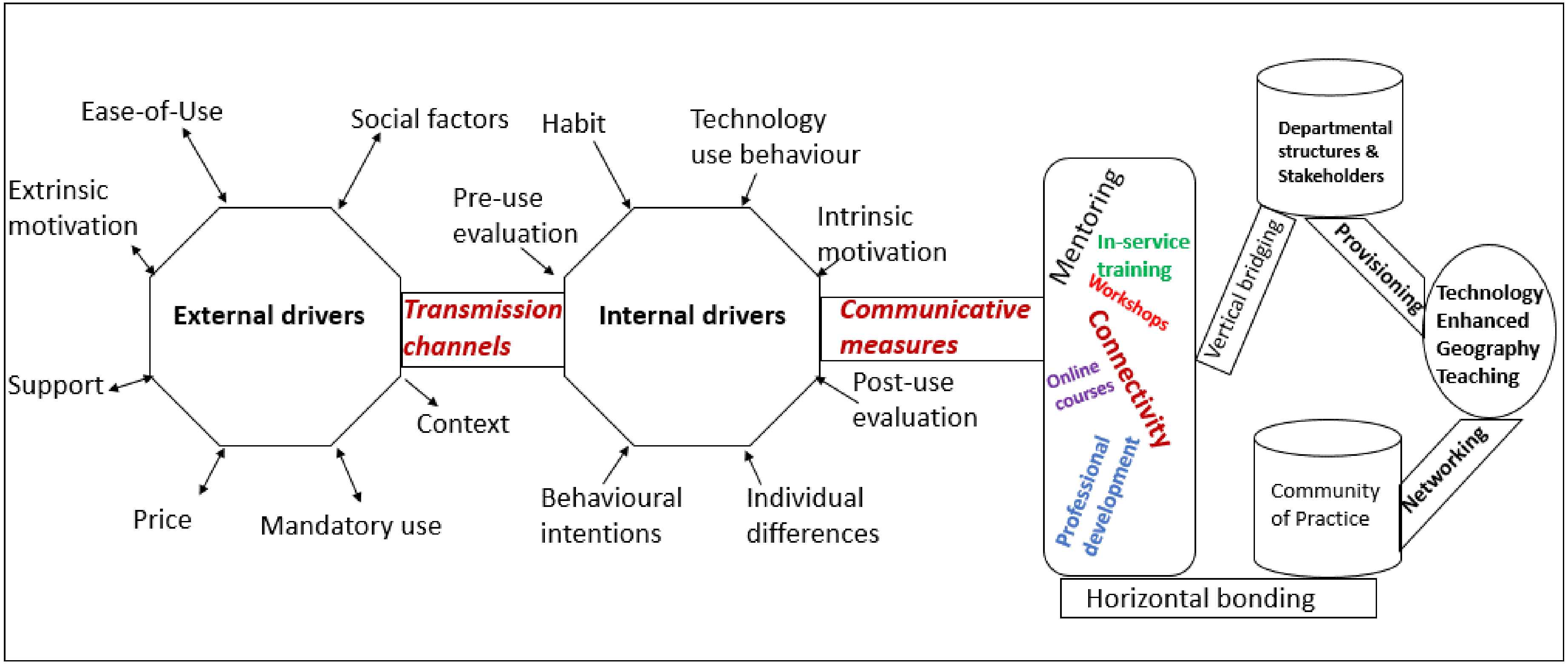


Figure 7.2: The model for Technology-Enhanced Geography Mapwork Teaching (TEGMT) Model [Source: the researcher]

7.10 Conclusion

This chapter theorised the findings from the data collection methods. Findings include data collected by means of a qualitative questionnaire which comprised closed-ended and open-ended questions based on six themes that originated from coding. Themes from data collected from focus groups, semi-structured interviews, observations, and document analysis are theorised in this chapter.

The discussion on all the themes that were generated from various data generation methods have been discussed as discrete entities in this chapter. However, they all contribute to the findings that the researcher arrived at and led the researcher to personal interpretations as presented in this chapter. The interpretation was done with reference to the theoretical frameworks that were explained in chapter 3. The conceptual frameworks of UTAUT and TPACK were used to frame the study while the theory of social capital was used to analyse the processes and technology integration and the assisted in developing the Technology-Enhanced Geography Mapwork Teaching model. Chapter 8 will present a summary of the findings that arose from the data analysis, and conclusions will be drawn based on the interpretations as presented in this chapter. The integration of technology was found to be inconsistent in various schools as it was apparent in the qualitative data gleaned from the qualitative questionnaire. Nevertheless, different practices were observed at the research site and data from document analysis presented, confirming cues concerning teachers' practices in the research site. The final chapter will present the conclusions drawn from these discussions.

CHAPTER 8

THE ECOLOGY OF IMPROVING TECHNOLOGY INTEGRATION IN TEACHING MAPWORK CALCULATIONS

8.1 Orientation to the chapter

This chapter summarises the efforts of the study by presenting the contribution of the study to academic knowledge, the recommendations and the limitations encountered during the research. The summation is based on the methods used to collect, present, analyse and interpret the findings regarding the integration of technology into the teaching of geography mapwork calculations in Grade 10 classes at a secondary school in the Umlazi District. A reflection on the findings and the process followed throughout the study to answer the research questions specified in chapter one, will be presented. The chapter outlines recommendations that could assist in laying the foundation for the integration of technology in the teaching of geography mapwork. All studies have limitations that must be articulated, therefore, methodological limitations to the study are explained in this chapter. Finally, the study also outlines some future research directions.

8.2 Summary of the Findings pertaining to the First Research Questions

The first research question: *How is technology professionally integrated in the teaching of Grade 10 geography mapwork calculations in a secondary school?*

The teachers' technological pedagogical content knowledge (TPACK) was found to be adequate in using observations, semi-structured interviews, and document analysis as methods to solicit data from the research site. However, technological knowledge (TK) was found to be inadequate in the sampled schools in the district, due to several factors that affect the implementation of technology in the classroom. Despite the lack in technological knowledge, teachers in the sampled schools had sufficient pedagogic knowledge (PK) as they were all qualified to teach Geography at Grade 10 level. The limited technological devices that they used to communicate and share documents among themselves and with their learners could not translate into the efficient integration of technology in the classroom context. Summarily, teachers at the research site could integrate technology in their teaching of mapwork calculations and the environment within the school enabled them to do so.

The second question: *Why do Grade 10 geography teachers at the secondary school teach mapwork calculations in the way that they do?*

It was apparent from the collected data that teachers at the research site integrate technology in their teaching due to the established facilitating conditions at the school. Policies, support from internal structures, provision and access to both print and technological resources, training of teachers and mentoring sessions among teachers within the school setting contributed to enhanced teaching and learning, using technology provided at the research site. Teachers realised the benefits of technology and visualised the content they taught, while providing opportunities to learners to access technology to improve their performance.

In comparison, teachers in the wider ambit of sampled schools in the pilot study did not have access to resources, nor did they enjoy adequate support from external structures while internal support was also minimal. Consequently, these teachers had to use whatever was available to teach mapwork calculations. Despite the lack of policies on technology integration, teachers in these schools decided to contravene their school policies in some instances, particularly, the disallowing of the use of cell phones within school premises, to assist their learners in visualising the content. In addition, the digital divide affected most of the teaching programmes that teachers sought to execute in the district and made it difficult to integrate technology in the classroom setting. Teachers at the research site managed to integrate technology in their teaching due to the above-mentioned conditions, while teachers in the wider context could not adequately integrate technology due to several prohibiting factors.

8.3 Theoretical Understanding of the Findings

The use of the Technological Policy and Support in Geography (TePaSiG) Model (Figure 6.13) as explained in chapter 6, could assist teachers in comprehending the factors that cause problems in integrating technology in their teaching of Geography. Furthermore, there is the possibility to assist them in understanding how they can overcome problems that hinder the integration in their geography classes. Mentoring within the schools could also be facilitated with the use of the Geographic Technology Mentoring (GTM) Model expressed in figure 6.15 in chapter 6. The understanding of the model provides a high degree of probability in the mentoring of inexperienced teachers by technologically conversant teachers in the integration teaching process.

8.4 Contribution to Academic Knowledge

This study sought to find out how teachers integrate technology in their teaching of geography mapwork calculations. This is vital to the communities of practice as the study informs on good practices and malpractices, so that geography teachers can further strengthen their integration in case of the former perceptions, and rectify their practices in the case of the latter. The study further identified the shortcomings in geography mapwork teaching, thereby creating a better understanding of teachers regarding the importance of technology integration in their classrooms. The case study design approach used in the study discourses on the actions a specific school undertook to raise the level of performance of its learners, despite the challenges most public secondary schools experience in the country. The case study approach presented a deeper insight into the functioning of discrete entities that ultimately form a plexus in technology integration within a public institution, namely, a secondary school in the Umlazi district.

The study has highlighted several factors that resulted in the inefficient integration of technology in schools within the district. This is vitally important for education practitioners, teachers and service providers who partner with the DBE to render support in the drive to establish internet connectivity in schools throughout the country as envisaged by the Department at provincial and national level. Internet connectivity identified as one of the major problems in facilitating online teaching and access to online resources in geography classrooms is partly due to the digital divide and the poor network infrastructure.

The study is also significant in contributing academic knowledge for Departmental officials to drive the ongoing national Research Agenda 2019-2023, particularly in the areas of Teacher development, Teacher support, ICT, Accountability and Infrastructure. In KwaZulu-Natal, the research hopes to contribute to the digital migration agenda in schools for 2020 to 2025 as envisaged in the *ICT Integration Plan for Digital Transformation* document from the Office of the Premier.

8.5 Recommendations

The DBE caters for the provision of technology resources to enable facilitating conditions in schools through a technology infrastructure. It should also provide room for teacher development programmes in technology integration for geography teachers. The formulation of policy regarding the integration of technology and the use of technological devices, including mobile phones, is deemed necessary for the effective teaching of mapwork calculations. The efficient functioning of the Professional Learning Communities (PLCs) must be made possible through constant monitoring by the Subject Advisors as laid down in the *Professional Learning Communities - Guidelines for South African Schools.* To enable PLCs to function effectively in schools, Pirtle (2014) suggested the following guidelines:

• Provide a clear structure and purpose for PLC meetings.

• Address the most pressing instructional challenges.

• Provide support from all levels of the school system.

• Foster an atmosphere of trust.

• Monitor the work of PLCs and provide constructive feedback.

• Support teachers' sense of efficacy and level of professionalism.

Insights gained from this study have shown that there is a high degree of probability that the Department and the entire schooling system could benefit from these guidelines, with the caveat of additional regulations where necessary. For these guidelines to take effect, the support from all relevant stakeholders in education is paramount in order to ensure an efficient integration of technology in geography classrooms. A time frame should be created for teacher development programmes at teacher centres and incentives be provided for teachers who complete their training.

8.6 Limitations to the Study

The study was specific to the district of Umlazi in KwaZulu-Natal. Its findings can only be applicable within the confines of similar schools in KwaZulu-Natal and possibly South Africa. However, transferability of the findings to other institutions of similar nature should not be underestimated. Although transferability is one criterion of the case study design, the methodology could perhaps have been more strengthened with quantitative elements as they would bring about an understanding of the extent of technology integration across a broad terrain. A further limitation was perpetuated by the advent of lockdown necessitated by the COVID-19 pandemic, which forced the researcher to modify the methodology that was initially envisaged. Nonetheless, the methods used in this research created a high degree of credibility as they were carefully selected to authenticate the data collected from participants. In addition, responses to the qualitative questionnaire did not reach the expected number as envisaged during the sampling stage. Nonetheless, the 83.3% response rate was adequate to infer credible conclusions.

8.7 Future Research

The current study focused on the integration of technology in the teaching of geography mapwork calculations at Grade 10 level. A longitudinal study could be conducted for the forthcoming grades to maintain continuity, as teachers usually upgrade together with their students to higher grades until they exit at Grade 12. These studies would further assist geography teachers to realise the effect of their integration in learner attainment in the ensuing grades. A different research design could be used to further strengthen the findings of this study, by exploring the extent of the integration through survey design methods. The findings obtained in this study presented a synopsis of a confined research site, with its idiosyncrasies, within a specified region. Future studies could be expanded to capture common practices in other districts, provinces and countrywide, and could include practices in private secondary education institutions.

This research study explored the integration of technology in the teaching of geography mapwork calculations through the practice of teachers at Grade 10 level. It is necessary to conduct a study that will view the integration of technology in geography mapwork learning on the part of learners at Grade 10 level, thereby presenting a complete picture of integration in the teaching and learning of this aspect at the same secondary school level.

8.8 Conclusion

South Africa has been experiencing poor results in relation to learner performances in Geography at Matric level. The poor performance has not received adequate and rigorous attention from researchers at junior grades in the FET phase. This necessitated the research to specifically explore the teaching of Geography in Grade 10, with particular attention to mapwork calculations as one aspect that most of the learners fail to master. The rationale for the focus on and exploration of Grade 10 is that this grade is most vital in the FET phase, as Geography assumes a more insulated position, thereby becoming an independent subject from

History, which is part of Social Sciences in the lower grades from the Intermediate to Senior phase. It is where Geography becomes more scientific and more demanding in terms of algebraic literacy and the use of scale, as well as following meticulously all the predetermined calculation steps to arrive at the correct answers.

This chapter summarises the issues that arose from the findings in the previous chapter. Recommendations are made to assist all concerned with the integration of technology in teaching the subject. Limitations to this study are highlighted for directions in possible future research into this phenomenon.

REFERENCES

Abrahao, R., Moriguchi, S.N. & Andreda, D.F. (2016). Intention of adoption of mobile payment: An analysis in the light of the Unified Theory of Acceptance and Use of Technology (UTAUT). *RAI Revista de Administraçao e Inovaçao, 13,* 221-230.

Aburub, F. & Alnawas, I. (2019). A new integrated model to explore factors that influence adoption of mobile learning in higher education: An empirical investigation. *Education Information Technology 4*(3), 2145-2158.

Adams, W. (2018). Conducting semi-structured interviews. In K. E. Newcomer, H.P. Harty and J. S. Wholey (Eds). Handbook of Practical Evaluation (4th ed.). Josey-Bass. https://doi.org/10.1009/9781119171386.ch19

AED/TAC. (2006). Introduction to Data Analysis Handbook. AED/TAC-12 Spring 2006, https://files.eric.ed.gov/fulltext/ed536788.pdf

Ahiaku, R. K. A., Mncube, D.W. & Olaniran, S. O. (2019). Teaching Mapwork in South African Schools: Reflections from Educators' Experiences, Concerns and Challenges. *IGIDA, 8*(1), 19-36.

Ahiaku, P.K.A. & Mncube, D.W. (2018). Geography Educators' Perceptions of Learner Performance in Grade 12 Geography in Public Schools. *Alternation Special Edition 21,* 68 – 90.

Ajayi, V.O. (2017, September). *Primary Sources of Data and Secondary Sources of Data*. https://www.researchgate.net/publication/320010397

Ajibade, B.A. & Bertram, C. (2020). How District Teacher Development Centres Support Teachers' Learning: Case Studies in KwaZulu-Natal. *Perspectives in Education, 38*(2), 103-117.

Al Balushi, K. (2017). The use of Online Semi-Structured Interviews in Interpretive Research. *International Journal of Science and Research, (IJSR), 7*(4), 726-732.

Alharbi, A. (2021). A review of the internal; and external factors affecting teachers' ICT use in the classroom. *International journal of Educational Research, 9*(12), 105-116.

Al Murshidi, G.H. & Wright, E. (2022). Using ICT and digital tools in teacher professional development in the UAE. Chapter 12. IGI Global. https://doi.org/10.4018/978-1-7998-9278-6.ch012

Alshare, K. A. & Lane, P. L. (2011). Predicting Student Perceived Learning Outcomes and Satisfaction in ERP Courses: An Empirical Investigation. *Communications of the Association for Information Systems, 28*(34), 571-584.

Amador, J.M., Kimmons, R., Desjardins, C.D. & Hall, C. (2019). Preparing Preservice Teachers to Become Self-Reflective of their Technology Integration Practices. *IGI Global*, 1298-1300.

Amosun, P. A. (2016). Group learning, Gender, Mathematical Ability and Students' Mapwork Skills. Ife Centre for Psychological Studies. *Ife Psychologia*, *24*(1), 12-21.

Anderson, O. (2018, March 28). *What is a pilot study?* A helpful guide for you. AllAssignmentHelp.

Pilot Study | What is a Pilot Study | Pilot Study definition and Meaning (allassignmenthelp.com)

Anderson, R. (2004). Intuitive inquiry: An epistemology of the heart for scientific inquiry. *The Humanistic Psychologist, 32*(4), 307-341.

Ankiewicz, P. (2020). Technology education in South Africa since the new dispensation in 1994: An analysis of curriculum documents and a meta-synthesis of scholarly work. *International Journal of Technology and Design Education, 31*, 939-963.

Anshari, M., Almunawar, M.N., Shrahill, M., Wicaksono, D.K. & Huda, M. (2017). Smartphone usage in the classroom: Learning aid or interference? *Educational Information Technology, 22*, 3063-3079. https://doi.org/10.1007/s10639-017-9572-7

Anyanwu, C.C., Govender, D.W. & Ngwenya, J.C. (2022). Integration of technology in Business Education: Emerging voices from secondary school classrooms in Nigeria. *E-Journal of Humanities, Arts and Social Sciences (RHASS), 3*(5), 160-174. https://doi.org/10.38159/ehass.2022351

Arain, M., Campbell, M. J., Cooper, C. L., & Lancaster, G. A. (2010). What is a pilot or feasibility study? *10*, 67. https://doi.org/10.1186/1471-2288/10/67

Arora, V. (2017). Why digital learning is so important for teachers and students. https://tech.co/news/digital-learning-teachers-students-2017-04-18.

Assan, T. & Thomas, R. (2012). Information and communication technology integration into teaching and learning: Opportunities and challenges for commerce educators in South Africa. *International Journal of Education and Development using Information and Communication Technology (IJEDICT), 8*(2), 4-16.

Atkinson, R.D. & Mckay, A.S. (2007). Digital Prosperity: Understanding the Economic Benefits of the Information Technology Revolution. Washington DC: ITIF.

Azgin, A.O. & Senler, B. (2018). Investigating the Technological Pedagogical Content Knowledge of Primary Teachers. *Journal of Computer and Education Research, 6*(11), 47-64.

Baker, L. (2006). Observation: A Complex Research Method. ResearchGate.

Balalle, H. & Weerasinghe, L.T. (2021). The Impact of Educational Technology in Teaching and Learning. *European Journal of Research and Reflection in Educational Sciences, 9*(1), 84-92.

Balboni, B. S. (2013). Making maps and atlases an everyday tool in school: A guide to using My First Atlas of Belize, and the World. http://dx.doi.org/10.1016/j.cosust

Banks, J. A. (1998). The lives and values of researchers: Implications for educating citizens in a multicultural society. *Educational Researcher*, *27*, 4–17.

Barhoumi, C. (2015). The Effectiveness of WhatsApp Mobile Learning Activities Guided by Activity Theory on Students' Knowledge Management. *Contemporary Educational Technology*, *6*(3), 221-238.

Barrick, M.F. & Mount, M.K. (1991). The big five personality dimensions and job performance: A meta-analysis. *Personnel Psychology*, *44*(1), 1-26. https://doi.org/10.1111/j.1744-6570. 1991.tb00688.x

Bartkus, V.O. & Davis, J.H. (2009) Social capital: Reaching out, reaching in. Edward Elgar Publishing: Northampton, MA. http://dx.doi.org/10.4337/9781848445963

Basri, W.S., Alandejani, J.A. & Almadani, F.M. (2018). ICT Adoption Impact on Students' Academic Performance: Evidence from Saudi Universities. *Educational Research International*, 1-9.

Baxter, P. & Jack, S. (2010). Qualitative case study methodology: Research design and implementation for novice researchers. *The Qualitative Report*, *13*(40, 544-559.

Bednarz, S. W. (n.d.). Maps and spatial thinking skills in the AP human geography classroom. http://apcentral.collegeboard.com/print/htm

Bednarz, S.W. (2011). Maps and spatial thinking skills in the AP human geography classroom. http://apcentral.collegeboard.com/apc/public/courses/teachers_corner/151317.html

Belland, B.R. (2009). Using the theory of habitus to move beyond the study of barriers to technology integration. *Computers & education 52*(2), 353-364.

Best, J.W. & Kahn, J.V. (2006). Research in Education (10th edition), Pearson Education Inc.: Boston, USA.

Bevans, R. (2020). *Confidence interval explained*. Scribrr. https://www.scribrr.com/statistics/confidence-interval/

Bhandari, H. & Yasunobu, K. (2009). What is Social Capital? A Comprehensive Review of the Concept. *Asian Journal of Social Science, 37*(3), 480-510.

Bhasin, H. (2020). Focus group interviews: Purpose, preparation and sample interviews. https://www.marketing91.com/focus-group-interviews

Biegon, T.C. (2017). The extent of ICT integration in public secondary school management and stakeholders' reception on the usefulness of the technology in Nairobi. Published MEd dissertation in Administration. Kenyatta University, Nairobi, Kenya.

Bijsterbosch, E. (2018). The Impact of National Examinations on Geography Teachers' Assessment Practices in The Netherlands. *Geography, 31*, 41-48.

Bin Yeop, Y.H., Othman, Z.A., Abdullah, S.N.H.S., Mokhtar, U.A., Fariza, W. & Fauzi, P. (2018). BYOD implementation factors: A case study in Malaysia. International *Journal of Advanced Computer Science Application (IJACSA), 9*(12), 311-317.

Bindu, C.N. (2016). Impact of ICT on Teaching and Learning: A Literature Review. *International Journal of Management and Commerce Innovations, 4*(1), 24-31).

Blandford, A. (2013). Semi-structured qualitative studies. In S. Mads and D. Rikke Friis (Eds). "The Encyclopaedia of Human-Computer Interaction (2nd ed.)". Aarhus, Denmark: The Interaction Design Foundation. http://www.interaction-design.org/encyclopedia/semi-structured_qual_studies_html

Bloomberg (2021). *South Africa will pay R218 billion for electricity from power ships* -CSIR. South Africa will pay R218 billion for electricity from powerships – CSIR - EMFSA

Bonsu, N. O., Bervell, B., Armah, J. K., Aheto, S. K., & Arkorful, V. (2021). "WhatsApp Use in Teaching and Learning during Covid-19 Pandemic Period: Investigating the Initial Attitudes and Acceptance of Students". *Library Philosophy and Practice (e-journal).* 6362.

Bowen, G.A. (2009). Document analysis as a Qualitative Research Method. *Qualitative Research Journal, 9(2),* 27-40. https://doi.org/10.3316/QRJ0902027

Boyce, P. (2022). Social capital definition. https://boycewire.com/social-capital-definition-and-examples/

Bradford, S. & Cullen, F. (2012). Research and research methods for youth practitioners. London: Routledge.

Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3,* 77-101. https://doi.org/10.1191/1478088706qp063oa

Breen, R.L. (2006). A Practical Guide to Focus Group Research. *Journal of Geography in Higher Education, 30*(3), 463-475.

British Educational Communications and Technology Agency (Becta). (2004). What the research says about using ICT in Geography. www.becta.org.uk/research

Brodie, K. & Borko, H. (2016). Professional Learning Communities in South African Schools and Teacher Education Programmes. HSRC: Cape Town.

Brooks, C. (2010). Why geography teachers' subject expertise matters. *Geography*. *95*(3), 143-148.

Brown, M (2019). *Should cell phones be allowed in schools*. http://www.schoolmoney.org/cell-phones-classroom/.

Brown, B.D., Horn, R.S. & King, G. (2018). The Effective Implementation of Professional Learning Communities, Alabama State University. *AJEL*, *5*, 53-59.

Bryman, A. (2004). Social Research Methods (4th ed.). Oxford University Press.

Burns, M. & Santally, M. (2019a). Designing Qualitative Research (7th edition). CA: SAGE Publishing.

Burns, M. and Santally, M.I. (2019b). Information and Communication Technologies in Secondary Education in Sub-Saharan Africa: Policies, Practicals, Trends and Recommendations. *Mastercard foundation Report. Secondary Education in Africa: Preparing Youth for the Future of Work*, 1-78.

Carrión-Martínez, J.J., Luque-de la Rosa, A., Fernández-Cerero, J.& Montenegro-Rueda, M. (2020). Information and Communications Technologies (ICTs) in Education for Sustainable Development: A Bibliographic Review. *Sustainability*, *12*, 3288. https://doi.org/10.3390/su12083288

Chavula, H.K. & Chekol, A. (2012). ICT Policy development Process in Africa. *International Journal of ICT Research and Development in Africa*, *1*(3), 20-45.

Child, D. (1998). *Psychology and the teacher (6th ed.).* Holt, Rinchart & Winston.

Chimmalgi, M., Jose, R. & Kumari, K.C. (2017). Effectiveness of early clinical exposure and e-learning in technology anatomy. *International Journal of Anatomy and Research*, *5*(1), 3398-3403.

Chisholm, L. (2004). The state of curriculum reform in South Africa: The issue of Curriculum 2005. In R. Southall, A Habib, and J. Daniel (Eds.). State of the Nation. HSRC, Pretoria.

Cho, J. & Trent, A. (2006). Validity in qualitative research revisited. *Journal of Qualitative Research*, *6*(3), 319-340.

Ciesielska, M., Boström, K.W. & Öhlander, M. (2018). Observation methods. In M. Ciesielska, D. Jemielniak (eds.), Qualitative Methodologies in Organization Studies. https://doi.org/10.1007/978-3-319-65442-3_2

Claridge, T. (2018). *What is bonding social capital?* https://www.cosialcapitalresearch.com/cite-website/

Cohen, L., Manion, L. & Morrison, K. (2006). Research methods in education (6th ed.). Routledge: Taylor and Francis.

Cohen, L., Manion, L. & Morrison, K. (2000). Research methods in education. *British Journal of Education*, *48*,446.

Coleman, J. (1990). The Foundations of Social Theory. Harvard University Press, Cambridge.

Combrincke, C. & Mntatse, N. (2019). Reading on paper or reading digitally? Reflections and implications of ePIRLS 2016 in South Africa. *South African Journal of Education*, *39*(2), 1 – 14.

Constance, S.M & Musarurwa, C. (2018). Integration of ICTs into the teaching and learning of Secondary School Geography: The Seychelles experience. *Journal of Geography Education in Africa (JoGEA)*, *1*,15-26. https://doi.org/10.46622/jogea.v1i.2535

Cope, M. (2010, January). *Coding qualitative data. ResearchGate*, 281-294. https://www.researchgate.net/publication/284143585

Cope, M. & Kurtz, H. (2016). Organising, Coding and Analyzing Qualitative Data. In N. Clifford, M. Cope, T. Gillespie, and S. French. (Eds). Key Methods in Geography (3rd ed.). SAGE: Los Angeles

Creswell, J.W. (2009). Research Design: Qualitative, Quantitative and Mixed Methods Approaches (3rd edition). SAGE Publications Inc.: Thousand Oaks.

Creswell, J.W. (2004). Qualitative Inquiry and Research Design: Choosing Among Five Approaches (2nd ed.). SAGE Publishers.

Creswell, J.W. & Poth, C.N. (2018). Qualitative Inquiry and Research Design; Choosing Among Five Approaches (4th edition). SAGE Publishers.: Thousand Oaks.

Crosley, J. & Jansen, D. (2020). Qualitative Data Coding101: How to code qualitative data, explained simply. https://gradcoach.com/qualitative-data-coding-101/

Crossman, A. (2020, August 27). *Pilot study in Research.* https://www.thoughtco.com/pilot-study-3026449

Cukurbasi, B., Isbulan, O. & Chopper, M. (2016). Acceptance of Educational Use of Tablet Computers: A Critical View of the FATIH Project. *Educ. Sci., 41*, 67–82.

Curtis, M. D. (2019). Professional Technologies in Schools: The Role of Pedagogical Knowledge in Teaching with Geospatial Technologies. *Journal of Geography, 118*(3), 130-142.

Dambudzo, I. I. (2014). Integrating ICT in Teaching and Learning Geography in a Secondary School: The Lived Experiences of Learners. *ARPN Journal of Science and Technology*, *4*(11), 631 – 638.

Daniela, L. (2019. Didactics of Smart Pedagogy: Smart Pedagogy for Technology-Enhanced Learning. Springer: Switzerland.

Darling-Hammond, L., Hyler, M.E. & Gardner, M. (2017). Effective Teacher Professional Development, Palo Alto, CA: Learning Policy Institute.

Davies, R.S. & West, R.E. (2013). Handbook of Research on Educational Communications and Technology (4th Edition). *Technology Integration in Schools.* https://doi.org/10.1007/978-1-4614-3185-5_68

Davis, B. (2021). What is data presentation in qualitative research? https://readinganswers.org/what-is-data-presentation-in-qualitative-research/

Davis, F. D., Bagozzi, R. & Warshaw P. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Manage. Sci. 35*(8), 982–1003.

Dearing J. & Cox, J. (2018). Diffusion of innovations theory, principles and practice. https://doi.org/10.1377/hithaff.2017.1104

De Guzman, M.D., Olaguer, L. & Novera, E.D.G. (2017). Difficulties faced in teaching geography lessons at public secondary schools' division of Zambales, Philippines. http://www.iosrjournals.org/iosrjhss/papers/Vol.%2022%20Issue9/Version-/I2209076470.pdf

Delve. Ho, L. & Limpaecher, A. (2022b, February 25). The Importance of Reflexivity in Qualitative Research. Essential Guide to Coding Qualitative Data. https://delvetool.com/blog/reflexivity

Denzin, N.K. & Lincoln, T.S. (2000). Handbook of Qualitative Research (2nd ed.). SAGE Publications.

Department of Basic Education. (2015). Professional Learning communities - A guide for South African Schools. DBE.

Department of Telecommunications and Postal Services (DTPS). (2016). National Integrated ICT Policy White Paper. Pretoria.

Department of Basic Education. (2016). National Integrated ICT Policy White Paper. Govt Printing Press.

Department of Basic Education. (2016). Status of e-education, particularly school connectivity. DBE.

Department of Basic Education. (2016). *2015 National Senior Certificate Examination Diagnostic Report.* www.education.gov.za/Resources/Reports.aspx

Department of Basic Education. (2017): *2016 National Senior Certificate Examination*

Diagnostic Report. www.education.gov.za/Resources/Reports.aspx

Department of Basic Education. (2018a): *2017 National Senior Certificate Examination Diagnostic Report*. www.education.gov.za/Resources/Reports.aspx

Department of Basic Education. (2018b): T*he 2017 National Senior Certificate Schools Subject Report.* www.education.gov.za/Resources/Reports.aspx

Department of Basic Education. (2018). *NSC National Diagnostic Report.* DBE.

Department of Basic Education. (2018). *NSC Examination: School Subject Report.* DBE.

Department of Basic Education. (2018). *Research Agenda: 2019-2023.* DBE.

Department of Basic Education. (2020). *Action Plan to 2024: Towards the Realisation of Schooling 2030-Taking Forward South Africa's National Development Plan*

DBE (2004). White Paper on eEducation: Correction Notice No.1869 of 2004, published on page 3 of Government Gazette No. 26734 of 26 August 2004. Government Printers.

Dockstader, J. (1999). Teachers of the 21st Century know the what, why, and how of technology. *THE Journal*, *26*(6), 73-75.

Donnelly, D., McGarr, O. & O'Reilly, J. (2011). A framework for teachers' integration of ICT into their classroom practice. *Computers & Education, 57*, 1469-1483.

Dowling, M. (2006). Approaches to reflexivity in qualitative research. *Nurse Researcher, 13*(3), 7-21.

Downing, J.R. (2011). Factors Influencing the Variability in Social Capital. Electronic Theses and Dissertations, (2004-2019), 1843.

DuFour, R., & Reeves, D. (2016). The futility of PLC lite. *Phi Delta Kappa*, *97*(6), 69-71. https://doi.org/10.1177/0031721716636878 du Plessis, E. C. (2020). A Reflection on identified challenges facing South African teachers. *The Independent Journal of Teaching and Learning, 15*(2), 69-91.

Durlauf, S.N. & Fafchamps, M. (2005). *Chapter 26: Social Capital*. Handbook of Economic Growth, Volume 1B. Elsevier B.V, 1639-1699.

Dwivedi, Y.K., Rana, N.P., Jeyaraj, A., Clement, M. & Williams, M.D. (2017). Re-examining the Unified Theory of Acceptance and Use of Technology (UTAUT): Towards a Revised Theoretical Model. *Information Systems Front, 21*, 719-734.

Eisner, E. W. (1991). The Enlightened Eye: Qualitative inquiry and enhancement of Educational practice. Collier MacMillan.

Eldridge, S.M., Lancaster, G.A., Campbell, M.J., Thabane, L., Hopewell, S., Coleman, C.L. & Bond, C.M. (2016). Defining feasibility and pilot studies in preparation for randomised control trials: development of a conceptual framework, *PLos One, 11*(3). https://doi.org/10.1371/journal.pone.0150205

Elo, S., Kaariainen, M., Klanste, O., Polkki, T., Utriainen, K. & Kyngas, H. (2014). Qualitative Content Analysis: A Focus on Trustworthiness. Sage Publishing. https://doi.org/10.1177/2158244014522633

EMFSA (2021, October 17). *South African government wireless connectivity in schools for new curriculum.* https://www.emfsa.co.za/news/south-african-government-morewireless-connectivity-in-schools-needed-for-new-curriculum/

Eneriz, A. (2019). How Teachers are Integrating Technology into the Classroom. North-Eastern University: Graduate Programs. https://www.northeaster.edu/graduate/blog/integrating-technology-into-teaching/

Erkan, A. (2019). Impact of Using Technology on Teacher-Student Communication/ Interaction: Improve Students Learning. *World Journal of Education, 9*(4), 30-40.

Estes, J.S. (2019). A call for Teacher Preparation Programs to Model Technology Integration into the Instructional Process. Pre-service and In-service Teacher Education: Concepts, methodological tools and applications. Park University: USA. https://doi.org/10.4018/978-1-5225-7305-0-ch.067

Evoh, C.J. (2011). ICT in education Development in Africa: Policy and Institutional Frameworks. IGI. https://doi.org/10.4018/978-1-61520-847-0.ch017

Ezeudu, S.A. & Utazi, O.L. (2014). Contemporary Gaps among Geography Teachers in the Teaching of Geography Mapwork in Secondary Schools in Kogi State. *Journal of Education and Practice, 5*(5), 41-48.

Feldman, J. & Fataar, A. (2016). Working through the 'hardness of teachers' pedagogical habitus: Pedagogical learning among teachers in a professional learning community. In K. Brodie and H. Borko (2016). PLCs in South African schools and Teacher Educational Programmes. HSRC.

Feldman, J. (2020). The role of PLCs to support teacher development: A social practice theory perspective. *South African Journal of Education, 40*(1), 1-8.

Felix, A.A. (2021). Integrating Geography Teaching and Learning Using Information and Communications Technology. PhD Thesis in the Faculty of Education, UFS, South Africa.

Fern, E.F. (2001). Advanced Focus Group Research. SAGE Publications.

Fleischmann, E. & van der Westhuizen, C.P. (2020). The educational research landscape on GIS integration and challenges - globally and in South Africa. *Journal of Geography Education for Southern Africa (JoGESA), 5*, 19-41.

Flick, U. W. E. (2009). An introduction to qualitative research. London: SAGE Publishing.

Fordham, I. & Goddard, T. (2013). Facebook Guide for Educators: A tool for teaching and learning. The Education Foundation HQ. www.facebook.com/educationfoundationuk

Fourie, M. & Deacon, E. (2015). Meaning in work of secondary school teachers: A qualitative study. *South African Journal of Education, 35*(3), 1–8.

Fraser, J., Fahlman, D., Arscott, J. & Guilot, I. (2018). Pilot Testing for Feasibility in a Study of Student Retention and Attrition in Online Undergraduate Programs. *International Review of Research in Open and Distributed Learning, 19*(1), 260-278.

Frazier, C.A. & Boehm, R.G. (2012). Using Technology for Geography Teacher Education: Web-based Professional Development. *Review of International Geographical Education Online, 2*(1), 78-94.

Frey, B. (2018). Document Analysis.: The SAGE encyclopaedia of educational research, measurement and evaluation (Vols 1-4). SAGE Publishers. Publications. https://dx.doi.org/10.4135/9781506326139.n209

Friederici, N., Ojanperä, S. & Graham, M. (2017). The Impact of Connectivity in Africa: Grand Visions and the Mirage of Inclusive Digital Development. *The Electronic Journal of information Systems in Developing Countries, 79*(2), 1 – 20.

Friedman, S, (2019). Using Technology to Inspire Creativity Boosts Student Outcomes. https://thejournal.com/articles/2019/10/31/using-technology-to-inspire-creativity-boosts-student-outcomes.aspx

Fullan, M. (2007). The new meaning of educational change (4th ed.). Teachers College Press.

Ghavifekr, S. & Rosdy, W.A.W. (2015). Teaching and learning with technology: Effectiveness of ICT integration in schools. *International Journal of Research in Education and Science (IJRES), 1*(2), 175-191.

Gillwald, A., Mothobi, O. & Rademan, B. (2018). The State of ICT In South Africa. Policy Paper No,5, Series 5.
https:///researchictafrica.net/after-access-south-africa-state-of-ict-2017-south-africa-report_04/July2018

George, D. & Mallery, P. (2001). SPSS for Windows. Needham Heights, Allyn & Bacon.

Gogtay, N. J. (2010). Principles of sample size calculation. *Indian Journal of Opthalmology, 58*(6), 517-518. https://doi.org/10.4103/0301-4738.71692

Gorman, G. E. & Clayton, P. (2005). Qualitative research for the information professional (2nd ed.). Facet.

Govender, N. & Khoza, S. (2017). Technology in Education for Teachers. In L. Ramrathan, L. Le Grange, and P. Higgs (Eds). Education Studies for Initial Teacher Development. Juta and Company (Pty) Ltd.

Graham, C.R., Borup, J. & Smith, N.B. (2012). Using TPACK as a framework to understand teacher candidates' technology integration decisions. *Journal of Computer Assisted Learning*, Blackwell Publishing Ltd, 1-17. https://doi.org/10.1111/j.1365-2729.2011.00472.x

Grant, A. (2020, January 3). *What is Data Analysis and Why is it Important?* https://www.makeuseof.com/tag/what-is-data-analysis/

Gray, D.E. (2009). Doing Research in the Real World. 2nd ed. Sage Publications

Guba, E.G. & Lincoln, Y.S. (2018). Competing Paradigms in Qualitative Research. In N.K. Denzin and Y.S. Lincoln (Eds). (1994). Handbook of Qualitative Research 105-117. Sage Publications.

Gunawan, J. (2015). Ensuring Trustworthiness in Qualitative Research. *Nursing Journal, 1*(1), 10-11.

Guruli, N., Flores, C., Laken, F., Duke, A. & Haviland, J. (2020). Access denied: Internet access and the right to education in South Africa. The Global Human Rights Clinic, University of Chicago Law School. ISBN#978-1-7334730-7-1.

Gwegwe, S. (2021, October 25). 'Matric exams to start with new WhatsApp rules, phones will be registered'. TheSouthAfrican.com https://www.thesouthafrican.com/news/matric-exams-whatsapp-rules-phones-cheating-grade-12-department-of-basi-education/

Habhab-Rave, S. (2011). The Policy of Uses of ICTs in Developing Countries: The Case of Tunisia. IGI Global. https://doi.org/10.4018/978-1-61520-847-0.ch048

Haßler, B., Major, L., Warwick, P., Watson, S. Hennessy, S., & Nicholl, B. (2016). Perspectives on Technology, Resources and Learning: Productive Classroom Practices, Effective Teacher Professional Development. Faculty of Education, University of Cambridge. http://tiny.cc/perspectives

Haddad and Alexandra (2002). "The Dynamics of Technologies for Education". In W. Haddad, and A. Drexler. (Eds.). Technologies for Education: Potentials, Parameters, and Prospects. Academy for Educational Development. UNESCO.

Haddad Wadi, D. & Jurich, S. (2002). "ICT for Education: Potential and Potency". In Haddad, W.& Drexler, A. (eds), Technologies for Education: Potentials, Parameters, and Prospects. Academy for Educational Development. UNESCO, 34-37.

Hannula, K. A. (2022). New ideas for teaching topo maps, groundwater, and advanced topics, face-to-face and online. *Journal of Geoscience Education, 70*(1), 1-1.

Harnish, R. J., Bridges, K. R., Sattler, D. N., Signorella, M. L., & Munson, M. (Eds.). (2018). The Use of Technology in Teaching and Learning. Retrieved from the Society for the Teaching of Psychology web site: http://teachpsych.org/ebooks/

Harris, J., Mishra, P., & Koehler, M. (2009). Teachers' technological pedagogical content knowledge and learning activity types: curriculum-based technology integration reframed. *Journal of Research on Technology in Education, 41*(4), 393–416.

Harris, J., Grandgenett, N., & Hofer, M. (2010). Testing a TPACK-based technology integration assessment rubric. In D. Gibson & B. Dodge (Eds.), Proceedings of Society for Information Technology & Teacher Education International Conference 2010 (pp. 3833–3840). Chesapeake: AACE.

Hart, S.A. & Laher, S. (2015). Perceived usefulness and culture as predictors of teachers attitudes towards educational technology in South Africa. *South African Journal of Education, 35*(4), 1-13.

Hayes, A.F. (2018). Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach. The Guilford Press.

Haynes, K. (2012, January). *Reflexivity in Qualitative Research*. https://www.researchgate.net/publication/286352842

Haywood, S. & Hutchings, M. (2004). ICT and Learning for the Future. Education studies: A Student Guide (1st edition). Routledge. eBook ISBN 9780203073650

Heale, R.. & Forbes, D. (2013). Understanding triangulation in research. *Evidence-Based Nursing, 16*(4). https://doi.org/10.1136/eb-2013-101494

Hegarty, B. & Thrompson, M. (2019). A teacher's influence on student engagement: Using smartphones for creating vocational assessment e-Portfolios. *J. Inf. Technol. Educ. Res.*, *18*, 113–159.

Herring, M.C., Koehler, M.J. & Mishra, P. (2016). Handbook of Technological Pedagogical Content Knowledge (TPACK) for Educators (2nd Edition).

Heystek, J. (2015). Principals' perceptions of the motivation potential of performance agreements in underperforming schools. *South African Journal of Education, 35* (2), *1 – 10.*

Hillier, W. (2021). A Step-by-Step Guide to the Data Analysis Process. https://careerfoundry.com/en/blog/data-analysis/the-data-analysis-process-step-bt-step/

Himmelsbach, V. (2021). How Education Technology in the classroom can impact on student learning. Top Hat. https://tophat.com/blog/how-does-technology-impact-student-learning/

Hinostroza, J.E., Labbé, C., Brun, M. & Matamala, C. (2011). Teaching and learning activities in Chilean classrooms: Is ICT making a difference? *Computers Education, 57*(1), 1358-1367.

Hiter, S. (2021). *What is Qualitative Data?* DATAMATION. https://www.datamation.co./big-data/what-is-qualitative-data/

Hodgekinson-Williams, C., Siebörger, I. & Terzoli, A. (2007). Enabling and constraining ICT practice in secondary schools: case studies in South Africa. *International Journal of Knowledge and Learning, Vol. 3, Nos. 2*(3), 171-190.

HSRC. (2005). *ICT Infrastructure*. www.hsrcpress.ac.za

Howie, S. J., Muller, A. and Patterson, A. (2005). ICTs in South African Secondary Schools. HSRC.

Hughes, J., Thomas, R., & Scharber, C. (2006, March). Assessing technology integration: The RAT–replacement, amplification, and transformation-framework. In *Society for Information Technology & Teacher Education International Conference*. Association for the Advancement of Computing in Education (AACE), 1616-1620.

Ige, O. M. (2016). Causes and remedies of low academic performance of students in public secondary schools: A study of Ijero local government area of Ekiti State (Online). https://wwwiiste.org/Journal:/index.php/RHSS/article/view/32142/

Ihmeideh, F.M. (2009). Barriers to the Use of Technology in Jordanian Pre-school Setting. *Technology, Pedagogy and Education*, *18*(3), 325-341.

ICASA, (2020). The State of the ICT Sector Report in South Africa, 2020. Government Printing.

In, J. (2017). Introduction of a pilot study. *Korean Journal of Anaesthesiology, 70*(6), 601-605. https://doi.org/10.4097/kjae.2017.70.6.601

Innes, L. M. (2012). South African School Geography: Underpinning the Foundation of Geospatial Competence. *South African Journal of Geomatics*, *1*(1), 92 -108.

Innes, L.M. (1998). Learning to read the South African 1:50 000 topographic map: The development of a self-instruction method. MEd Dissertation, University of Johannesburg, South Africa.

Innes, L.M. (1998). Map awareness and map literacy. Journal, Monthly newsletter. Directorate: Communication Services of the Department of Land Affairs, Pretoria, 1/98, 9-10.

Isaacs, S. (2007). ICT in Education in South Africa: A Survey of ICT integration in Africa. South Africa Country Report. www.infodev.org

Isaacs, S., Roberts, N. and Spencer-Smith, G. (2019). Learning with mobile devices: A comparison of four mobile learning pilots in Africa. *South African Journal of Education*, *39*(3), 1 – 13.

Iwu, C.G., Gwija, S.A., Benedict, H.O. & Tengeh, R.K. (2013). Teacher job satisfaction and learner performance in South Africa. *Journal of Economics and Behavioral Studies*, *5*(12), 838-850.

Jansen, J. (1999). The school curriculum since Apartheid: Intersections of politics and policy in the South African transition. *Journal of Curriculum Studies*, *31*(1), 57-67.

Jimenez, E. C. (2020). Motivating factors of teachers in developing supplementary learning materials (SLMs). *Online Submission*, *8*(5), 108-113. http://dx.doi.org/10.21474/IJAR01/10912

Joan, D.R.B. (2013). Flexible learning as new learning design in classroom process to promote quality education. Research Papers. https://files.eric.ed.gov/fulltext/EJ1098325.pdf

Johnson, A. M., Jacovina, M. E., Russell, D. E., & Soto, C. M. (2016). Challenges and solutions when using technologies in the classroom in S. A. Crossley & D. S. McNamara (Eds.). Adaptive educational technologies for literacy instruction (pp. 13-29). Taylor & Francis.

Jude, L. T., Kajura, M. A., & Birevu, M. P. (2014). Adoption of the SAMR Model to Assess ICT Pedagogical Adoption: A Case of Makerere University. *International Journal of eEducation, e-Business, e-Management and e-Learning*, *4*(2), 106-n/a. http://dx.doi.org/10.7763/IJEEEE.2014.V4.312

Julious, S.A. (2019). Calculation of confidence intervals for a finite population size. *Pharmaceutical Statistics, (18),* 115–122. https://doi.org/10.1002/pst.1901

Jung, A. (2020). What is a sampling frame in psychology? What is a sampling frame in psychology? (findanyanswer.com)

Kadhim, A. J. (2021). Effective Use of ICT for Learning and Teaching Geography. *Aalborg*

Academy Journal of Human and Social Sciences, 1(1), 15-42.

Kadir, H., Kadir, M., Yusuf, T.M. & Rasheed, D. (2014). Role of ICTs in Enhancing a Sustainable Educational Development in Selected Secondary Schools in Ilorin Metropolis. *Journal for Economic and Sustainable Development, 5,* 89–93.

Kafu-Quvane, B. P. (2021). Chronicling teachers' experiences on integrating information and communication technology across the curriculum. *The Journal for Trans-disciplinary Research in Southern Africa, 17*(1), 1-7. https://doi.org/10.4102/td.v17i/.783

Kafyulilo, A, Fisser, P., Pieters, J. & Voogt, J. (2015). ICT Use in Science and Mathematics Teacher Education in Tanzania: Developing Technological Pedagogical Content Knowledge. *Australasian Journal of Educational Technology, 31*(4), https://www.learntechlib.org/p/152297/

Kallio, H., Pietilá, A., Johnson, M. & Kangasniemi, M. (2016). Systematic methodological review: Developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing, 72*(12), 2954-2965. https://doi.org/10.1111/jan.13031

Kamau, K.G. (2012). Constraints in the use of ICT in teaching learning processes in secondary schools in Nyandarua South District, Nyandarua County, Kenya. MED Dissertation, Kenyatta University, Kenya.

Kankam, P.K. (2017). Internet-based Information behavior of high school learners in Ashanti Region of Ghana. PhD Thesis, University of KwaZulu-Natal, School of Social Sciences, College of Humanities, Pietermaritzburg, South Africa.

Kawulich, B. (2012). *Collecting data through observation*. ResearchGate.

Khan, M.S., Khan, I., Din, S., Ishmail, H.M., Khattak, R. & Jan, R. (2015). The Impact of

ICT on the students' performance: A review of Access Information. *Research on Humanities and Social Sciences, 5*(1), 85-94.

Khoza, S.B. & Manik, S. (2015). The recognition of digital technology refugees amongst post-graduate students in higher education institutions [Special issue]. *Alternation, 17*,190-208. http://alternation.ukzn.ac.za/Files/docs/22%20%SpEd17/10%20%Khoza%20F.pdf

Kimmons, R. (2018). Technology Integration: Effectively Integrating Technology in Educational Settings. In A. Ottenbreit-Leftwich & R. Kimmons, The K-12 Educational Technology Handbook. EdTech Books. https://edtechbooks.rog/k12handbook/technology_integrtion

Kini, T. & Podolsky, A. (2016). Does Teaching Experience Increase Teacher Effectiveness? A Review of the Research. Learning Policy Institute, 1-64. https://learningpolicyinstitute.org/sites/default/files/product_files/Teaching_Experience_Report_June_2016.pdf

Klimova, B. (2019). Impact of Mobile Learning on Students' Achievement Results. *Education Sciences*, *9*(90), 1-8.

Kocalar, A.O. & Demirkaya, H. (2017). Geography Teachers' Views on Effective Geography Teaching. *Reviews of International Geographical Education Online, 7*(3), 332-346.

Koehler, M. & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education, 9*(1), 60-70.

Koh, J.H.L., Chai, C. S. & Tsai, C. C. (2010). Examining the technological pedagogical content knowledge of Singapore preservice teachers with a large-scale survey. *Journal of Computer Assisted Learning, 26,* 563-573.

Korstjens, I. & Moser, A. (2018). Series: Practical guidance to qualitative research Part 4.:

Trustworthiness and publishing. *European Journal of General Practice, 24*(1), 120-124.

Kothari, C.R. (2004). Research Methodology: Methods and Techniques (2nd Revised ed.). New Age International Publishers.

Kowalski, K. (2019). When Smartphones go to school. https://www.sciencenewsforstudents.org/article/when-smartphones-go-school

Krejcie, R.V. & Morgan, D.W. (1970). Determining Sample Size for Research Activities. *Educational and Psychological Measurement*

Kumar, R. (2011). Research Methodology: A step-by-step guide for beginners. SAGE.

Kumar, R. (2014). Research methodology: A step-by-step guide for beginners (4th ed.). SAGE.

Kumaraswamy, M.N. (2018). An Effective Use of ICT for Education and Learning. *International Journal of Innovative Research and Advanced Studies (IJIRAS), 5*(2), 195 – 201.

Kvale, S. & Brinkman, S. (2009). Interviews: Learning the Craft in Qualitative Research Interviewing. Sage Publishing.

KZNDBE. (2020). ICT Roll-out: Department of Basic Education Briefing – Coronavirus measures, 17 March 2020. https://pmg.org.za/committee-meeting/30052

KZN Office of the Premier. (2020). KwaZulu-Natal Digital Transformation Strategy 2020-2025. Moses Kotane Institute, KZN, RSA.

Lafon, M. (2009). The Impact of Language on Educational Access in South Africa. https://halshs,archives-actuertes,fr/halshs-00451832

Lane, R. (2018). Concepts, Conceptualisation and Concepts in Geography. *Journal of Geography. 118*(1), 11-20.

Lanteria. (2021). The Semi-structured Interviews: Definition, Benefits, Requirements. https://www.lanteria/news/semi-structured-interviews-definition-benefits-requirements

Larangeria, R. & van der Merwe, C. D. (2016). Map literacy and spatial cognition challenges for student geography teachers in South Africa. *Perspectives in Education, 34*(2), 120 – 138.

Lawless, K. A., & Pellegrino, J. W. (2007). Professional development in integrating technology into teaching and learning: knowns, unknowns, and ways to pursue better questions and answers. *Review of Educational Research, 77*(4), 575–614.

Le Grange, L. & Beets, P. (2005). Geography Education in South Africa after a Decade of Democracy. *Geography, 90*(3), 267-277.

Limayem, M., Cheung, C., & Chan, G. (2003) "Explaining Information Systems Adoption and Post-Adoption: Toward an Integrative Model". ICIS 2003 Proceedings. Paper 59. http://aisel.aisnet.org/icis2003/59

Li, P., Knox, L.R. & Wright, R. (2015). Geography education in rural Tennessee Counties, Upper Cumberland Geography Teacher Survey. *Geography, 88*(1), 63-74.

Lincoln, Y.S. & Guba, E.S. (1985). Naturalistic Inquiry. Sage Publications.

Locsin, A. (2018). A List of Geography Careers. https://work.chron.com/list-geography-career4287.html

Locsin, C.D. (2018). ICT for Better Education in the Pacific. Asian Development Bank (ADB).

Lundall, P. & Howell, C. (2000). *Computers in schools: A National survey of Information Technology in South African schools*. Education Policy Unit of the University of the Western Cape: Cape Town.

Lynch, M. (2020). Evaluating technology integration in schools. https://www.thetechadvocate.org/evaluating-technology-integration-in-schools/

Madikiza, L. (2011). Broadcast Digital Migration Policy in South Africa. Development Bank of Southern Africa, SA.

DOI: 10.4018/978-1-61520-847-0.ch003

Maduane, L.H. (2016). Barriers to Geography Learning and Teaching in Grade 12 in the Limpopo Province, PhD Thesis, School of Education, FoH, University of Limpopo.

http://ulspace.ul.ac.za/bitstream/handle/10386/1537/maduane_lh_2016.pdf?sequence=1&isAllowed=y

Majumdar, A. (2019). Chapter 9: Thematic Analysis in Qualitative Research. *IGI Global*, 197-220. https://doi.org/10.4018/978-1-5225-5366-3.ch009

Manik, S. & Mahlalela, T. (2018). Through the Lens of Teachers: The Use of Geography CAPS Textbooks, Concomitant Challenges and a Reimagining of the Textbook. *Alternation Special Edition 21*, 37 – 67.

Mannova, B. & Preston, C. (2017). Computer Science inclusion in the school curriculum. *Education 17 Proceedings*, 2682-2684.

Maonga, T.W. (2015). Influence of reflective inquiry-based teaching on public secondary schools' students' performance in Geography mapwork in Kenya. University of Nairobi, Kenya.

Maphalala, M.C. & Nzama, M.V. (2014). The Proliferation of Cell Phones in High Schools: The Implications for the Teaching and Learning Process. *Mediterranean Journal of Social Sciences*, *5*(3), 461-466.

Marshall, C. & Rossman, G. (1980). Designing Qualitative Research. Sage. Publishing.

Marshall, C. & Rossman, G.B. (1999). Designing Qualitative Research (3rd ed.). Sage Pub.

Marshall, C., Rossman, G.B. & Blanco, G.L. (2021). Designing Qualitative Research (7th ed.). Sage Publishing.

Maud, A. (2018). Geography and powerful knowledge: A contribution to the debate. *International Research in Geographical and Environmental Education, 27*(2), 179-190.

McNulty, N. (2021. Digital learning in South Africa: Learning by design. https://www.niallmcnulty.com/2020/02/sona-and-digital-learning-in-south-africa/

Merriam, S. B. (1988). *Case study research in education: A qualitative approach.* Jossey-Bass. https://doi.org/10.23962/10539/28658

Merriem-Webster.com Dictionary. Basic Science. https://www.merriam-webster.com/dictionary/basic%20science

Maromo, J. (2020, April 17). Almost 400 SA schools vandalized during the Covid-19 lockdown. African News Agency/ANA.

https://www.iol.co.za/news/politics/almost-400-sa-schools-vandalised-during-covid-19-lockdown-468323

Masikirikwe, A. & Sokpuwu, A.I. (2019). Staff Development and Teachers' Performance in Public Secondary Schools in River State. *International Journal of Educational Research and Management Technology*, *4*(4), 73-102.

Mathevhula, M.D. & Uwizeyimana, D.E. (2014). The Challenges Facing the Integration of ICT in Teaching and Learning Activities in South African Rural Secondary Schools. *Mediterranean Journal of Social Sciences, 5*(20), *1 – 11.*

Maude, A. (2018). Geography and powerful knowledge: A Contribution to the debate. *International Research in Geographical and Environmental Education*, *27*(2), 179-190. https://doi.org/10.1080/10382046.2017.1320899

Mbuza, E. (2020, April 30). Nearly 1,000 schools vandalized since start of lockdown, food stolen. Times Live. https://www.timeslive.co.za/news/south-africa/2020-04-30-nearly-1000-schools-vandalised-since-start-of-lockdown-food-stolen/

Mdlongwa, T. (2012). Information and Communication Technology as a Means of Enhancing Education in Schools in South Africa: Challenges, Benefits and Recommendations. Policy Brief: Africa Institute of South Africa, No. 80.

Mendelyan, A. (2021). Coding Qualitative Data: How to Code Qualitative Research. Thematic Analysis. https://getthematic.com/insights/coding-qualitative-data/

Merriam, S.B. Johnson-Bailey, J., Lee, M.Y., Kee, Y., Ntseane, G. & Muhamad, M. (2001). Power and positionality: Negotiating insider/outsider status within and across cultures. *International Journal of Lifelong Education, 20*(5), 405-416. https://doi.org/10.1080/02601370120490

Meyer, I.A. & Gent, P.R. (2016). The status of ICT in education in South Africa and the way forward. NECT Report.

Mike, A. (2017). *Covert Observation.* Sage Publications. https://dx.doi.org/10.4135/9781483381411.n106

Mikre, F. (2011). The Roles of ICT in Education: Review article with emphasis on the computer and internet. *Ethiopian Journal of Education and Science, 6*(2), 47-55.

Milson, A.J. (2021). Technology in the Geography Classroom. National Geographic: Learning, T20-21.

Mishra, P., Koehler, M. and Henriksen, D. (2010). The 7 transdisciplinary habits of mind: Extending the TPACK framework towards 21st Century learning. *Educational Technology, 51*(2), 22-28.

Mishra, P. & Koehler, M.J. (2006). Technological Pedagogical Content Knowledge: A

Framework for Teacher Knowledge. *Teachers College Record 108*(6), 1017- 1054.

Ministry of Education (MoE) Trinidad & Tobago (2015). An ICT Professional Development Implementation Plan for Educators in Trinidad & Tobago. Govt Printers.

Mndzebele, N. (2013). Challenges Faced by Schools when Introducing ICT in Developing Countries. *International Journal of Humanities and Social Sciences Invention*, *2*(9), 1-4.

Ministry of Education (MoE): Trinidad & Tobago (2015). An ICT Professional Development Implementation Plan for Educators in Trinidad & Tobago. Government Printers.

Moeller, A.J. & Catalano, J. (2015). Foreign language teaching. In J.D. Wright (Ed.). International Encyclopaedia for Social and Behavioural Sciences (2nd ed.), 9, 327-332. https://doi.org/10.1016/B978-0-08-897086-8.92082-8

Moga, O.K. & Obuba, E. (2017). Assessment of Teachers' Challenges in Integrating ICT in Teaching Geography in Nyamira North Sub-County. *International Journal of Humanities and Social Science Invention*, *6*(11), 17-22.

Mooketsi, B. & Chigona, W. (2014). Different shades of success: Educator perception of government strategy on eEducation in South Africa. *The Electronic Journal of Information Systems in Developing Countries*, *64*, 1-5.

Morawski, M. & Budke, A. (2017). Language awareness in geography education: An analysis of the potential of bilingual geography education for teaching geography to language learners. *European Journal of Geography*, *7*(5), 61-84. https://www.researchgate.net/publication/315110626

Morgan, D.L. (2013). Focus groups as qualitative research: Planning and research design for focus groups. SAGE Research methods, Sage Publications.

https://doi.org/10.4135/9781412984287.n4

Morgan, D. L. & Hoffman, K. (2018). A System for Coding the Interaction in Focus Groups and Dyadic Interviews. *The Qualitative Report*, *23*(3), 519-531. https://doi.org/10.46743/2160-3715/2018.2733

Mosoge, M.J., Challens, B.H. & Xaba, M.I. (2018). Perceived collective teacher efficacy in low performing schools. *South African Journal of Education*, *38*(2), *1 – 9.*

Moussa, R.H. (2019). Digital is the pathway to the Africa we deserve. http://blogs.worldbank.org/team/rabiatou-harouna-moussa

Msila, V. (2007). From Apartheid Education to the Revised National Curriculum Statement: Pedagogy for Identity Formation and Nation Building in South Africa. *Nordic Journal of African Studies*, *16*(2), 146-160.

Msuya, O. (2015). Using mobile phones in teaching and learning in secondary schools in Tanzania. *International Journal of Education and Research, 3*(5) 207-218.

Mubanga, D. (2012). Education policies in Post-Apartheid South Africa: The National Curriculum and the Social Stratification of Working-Class Families. Published MA Dissertation. University of the Witwatersrand, Johannesburg, South Africa.

Munje, N.P. & Maarman, R. (2017). Do school resources matter? The effects of school resources on learner performance in poor school communities. *Journal of Educational Studies 16*(1), 34-51.

Munn, Z., Tufanaru, C.& Aromataris, E. (2014). JBI's systematic reviews: data extraction and synthesis. *American Journal of Nursing*, *114*(7), 49-54.

Mutlu, H.M. & Der, A. (2017). Unified Theory of Acceptance and Use of Technology: The Adoption of Mobile Messaging Application. *Megatrend Review*, *14*(1), 109-186.

Mwapwele, S. D., Marais, M., Dlamini, S., & van Biljon, J. (2019). Teachers' ICT adoption in South African rural schools: A study of technology readiness and implications for the South Africa Connect broadband policy. *The African Journal of Information and Communication (AJIC), 24*, 1-21.

Mwenesongole, E. (2009). The Factors Influencing Learner Achievement in Geography Mapwork at Grade 12 Level. *International Journal of Learning, 16*(8), 529-544.

Naxweka, J. & Wilmot, D. (2019). Namibian teachers' perceptions and practices of teaching mapwork. *Journal of Geography Education for Southern Africa, 4*(2), 2517-9861.

Ncube, N. (2018). ICT Integration in the Teaching of FET Geography in Johannesburg East. MED Dissertation. Wits University: Johannesburg, South Africa.

Ndlovu, N.S. & Lawrence, D. (2012). The quality of ICT uses in South African classrooms. Conference proceedings at UCT, 3 – 7 Sept. 2012, Wits University, South Africa.

Ndongfack, M. N. (2015). TPACK Constructs: A Sustainable Pathway for Teachers Professional Development on Technology Adoption. *Creative Education, 6*, 1697-1709. http://dx.doi.org/10.4236/ce.2015.616171

NEIMS (2021). National Education Infrastructure Management Systems Report as at 12 April 2021. NEIMS STANDARD REPORT 2021.pdf (education.gov.za)

Newton, N. (2010). The use of semi-structured interviews: Exploring qualitative methods.

(23) The use of semi-structured interviews in qualitative research: strengths and weaknesses | Dr Nigel Newton - Academia.edu

Ngalomba, S. (2020). Using WhatsApp to enhance online learning. University World News: Africa Edition.

https://www.universityworldnews.com/post.php?story=20202421102812987

Ngesi, N., Landa, N., Madikiza, N., Ceksiso, M.P., Tshotsho, B.& Walters, L.M. (2018).

Use of mobile phones as supplementary teaching and learning tools to learners in South Africa. *Reading & Writing, 9*(1), 190, 1-12.

Ngqakamba, S. (2020, April 16). Gauteng school break-ins: More arrests as number of vandalised, robbed schools spikes to 67. News 24. https://www.news24.com/news24/southafrica/news/gauteng-school-breakins-more-arrests-as-number-of-vandalised-robbed-schools-spikes-to-67-20200416

N'guessan, N.A. (2019). In Corte d' Ivoire the digital train is on the move but must go faster and further. http://blogs.worldbank.org/team/nafiisa-adgowa-nguessan

Ngwane, K. & Mbatha, B. (2017). ICT as a tool for teaching and teacher development: A case study of Mthunziwoxolo Secondary School in KwaZulu-Natal. EduLearn 17 Proceedings, 702-711.

Nkomo, L.M., Daniel, B.K. & Butson, R.J. (2021). Synthesis of student engagement with digital technologies: a systematic review of the literature. *International Journal of Educational Technology in Higher Education, 18*(34), 1-26.

Nkula, K. & Krauss, K.E. M. (2014). The integration of ICTs in marginalised schools in South Africa: Considerations for understanding the perceptions of in-service teachers and the role of training. In Steyn, J., Van Greunen, D. (Eds). (2014). ICTs for inclusive communities in developing societies. Proceedings of the 8th International Development Informatics Association Conference, held in Port Elizabeth, South Africa. 241-261. ISBN: 978-0-620-63498-4

Noble, H. & Heale, R. (2019). Triangulation in research, with examples. *Evidence Based Nursing, 22*(3), 67-68.

Ntuli, E. & Kyei-Blankson, L. (2013). Teacher Assessment in Technology: Integrated early childhood classrooms. In Handbook of Research on Teaching and Learning in K-20 Education, (IGI Global), 300-316.

Nulsem, C.R. (2020, November 9). Cell Phones at School: Should They Be Allowed? https://www.familyeducation.com/life/kids-cell-phones/cell-phones-schools-should-they-be-allowed

Oblinger, D. (1992). Multimedia in Instruction. Institute for Academic Technology. In K. Donert (2015). Chapter 1: Aspects of computer use in learning and teaching Geography in European Higher Education. Research Geography. http://www.uni-sofia.bg/faculties/geo/

O'Connor, H., Medge, C., Shaw, R. & Wellens, J. (2008) 'Internet-based Interviewing', In N, Fielding, R.M, Lee and G Blank, The SAGE Handbook of Online Research Methods. Sage Publishing.

OECD (2016), Education at a Glance 2016: OECD Indicators, OECD Publishing.

OECD. (2017). Education at a Glance 2017: OECD Indicators, OECD Publishing.

OECD. (2018). Education at a Glance 2018: OECD Indicators, OECD Publishing.

OECD, (2021). Education at a Glance 2021: OECD Indicators, OECD Publishing.

Oladosu, K. (2012). Basic Technology Teachers' Awareness and Attitude Towards the Use of Information and Communication Technology for Sustainable Development in Lagos State Education Districts: I, IV and VI. *Journal of Education and Practice, 3*(13), 1-12.

Omoro, B. & Nato, L.W. (2014). Determining methods used in teaching geography in secondary schools in Rongo District, Kenya. *International Journal of Academic Research in Progressive Education and Development, 3*(1), 220-232.

Ontong, K. & Khule, K. (2020). The need for a stronger integration of technology with school-based mapwork. *Geography, 105*(2), 94-100. https://doi.org/10.1080/00167487.2020.12094094

Onyumba, T.O., Wilson, K., Derrick, C.J. & Mukherjee, N. (2018). The Use of Focus Group Discussion Methodology Insights from two decades of application in conversation. *Methods in Ecology and Evolution, 9*, 20-32.

Osakwe, J.O., Iyawa, G., Ujakpa, M. & Florich, K. (2019). Enabling Quality Education in Namibia Through Mobile Learning Technologies: The High School Teachers' Perspective. *1st Africa 2019 Conference Proceedings, 11MC*, 1-9.

Oshlyansky, L., Cairns, P., & Thimbleby, H. (2007). Validating the Unified Theory of Acceptance and Use of Technology (UTAUT) Tool Cross-culturally. People and Computers XXI HCI. But Not as We Know it - Proceedings of HCI 2007: The 21st British HCI Group Annual Conference, 2 (September). https://doi.org/10.14236/ewic/hci2007.67

O'Sullivan, J. (2015). Digital Strategy for Schools 2015-2020: Enhancing teaching, learning and assessment. Department of Education and Skills, Ireland. Government Printers.

Owston, R.D. (2018). Sustaining Technology Innovations in the Classroom: What does it take? https://www.researchgate.net/publication/267966646

Padayachee, K. (2017). A Snapshot Survey of ICT Integration in South African School. *South African Computer Journal, 29*(2), 36-65. https://doi.org/10.18489/sacj.v29i2.4

Pademakar, P. (2020). What is Qualitative Data Analysis? EDUCBA. https://www.educba.com/what-is-qualitative-data-analysis/

Palomba, C.A. & Banta, T.W. (1999). Assessment essentials: Planning, Implementing and Improving Assessment in Higher Education. Jossey-Bass.

Pandey, P. & Pandey, M.M. (2015). Research Methodology: Tools and Techniques. Bridge

Center.

Patnaik, E. (2013). Reflexivity: Situating the Researcher in Qualitative Research. *Humanities and Social Science Studies, 2*(2), 98-106.

Pelgrum, W. J., & Law, N. (2003) "ICT in Education around the World: Trends, Problems and Prospects" UNESCO-International Institute for Educational Planning. In T. Plomp, W.J. Pelgrum, and N. Law, (2007), 'SITES2006— International comparative survey of pedagogical practices and ICT in education'. *Education and Information Technology, 12*(2), 83- 92.

Petrovic, T. (2021). Digital classroom. Academia Letters. Article 1522, 1-4. https://doi.org/10.20935/AL1522

Phakathi, B. (2019). School infrastructure is still largely inadequate, Business Day (Apr. 2019), https://www.businesslive.co.za/bd/national/2019-04-08-school-infrastructure-is-still-largely-inadequate/

Phillips, M. (2015). Models of technology integration. https://www.researchgate.net/publication/281244677

Philipsen, B., Tondeur, J., & Zhu, C. (2015). Using TPACK to Examine Teacher Professional Development for Online and Blended Learning. In A. Jefferies, & M. Cubric (Eds.). *Proceedings of the 14th European Conference on e-Learning (pp. 802-805). University Of Hertfordshire, Hatfield: Academic Conferences and Publishing International Limited.*

Pillay, H. & Hearne, G. (2010). Digital Review of Asia Pacific 2009–2010: Public-private Partnerships in ICT for Education.

Pirtle, S.S. (2014). Implementing Effective Professional Learning Communities. *SEDL Insights, 2*(3), 1-8.

Plaza-De la Hoz, J. (2018). How to improve the use of ICT to promote empowerment in education in sustainable development. *Aloma*, *36*, 43–55.

Polit, D.F. & Hungler, B.P. (1993). Chapter 3: Research Methodology. https://uir.unisa.ac.za/bitstream/handle/10500/1450/04chapter3.pdf

Prasad, M. & Garcia, C. (2017). How to Conduct a Successful Focus Group Discussion. https://humansofdata.atlan.com/2017/09/conduct_successful_focus_group_discussion/

Price, J.H. & Marman, J. (2004). Research limitations and the Necessity of Reporting Them. *American Journal of Health Education*, *35*, 66-67.

Prinsloo, C.H., Rodgers, S.C. & Harvey, J.C. (2018). The impact of language factors on learner achievement in science. *South African Journal of Education*, *38*(1), *1 – 14.*

Prior, B. (2020). The problem with South African children learning online. MyBroadBand Trusted in Tech. The problem with South African children learning online (mybroadband.co.za)

Priva, B.A.F. (2019). Using all aspects of digital technology to create Africa's new reality. http://blogs.worldbank.org/team/belem-abdow/fataph-priva

Rahman, M. & Ul-Aziz, M. (2019). ICT skills training critical for Bangladeshi youth. Worldbank Organisation. http://blogs.worldbank.org/team/mustahsin-ul-azziz

Raja, U., Johns, G. & Ntalianis, F. (2004). The impact of personality on psychological contracts. *Academy of Management Journal*, *47*(3), 350-367. https://doi.org/10.2307/29159586

Raksha, J. (2019). Technology Teachers' Perspectives on the Technology Curriculum. PhD Thesis. University of KwaZulu-Natal, College of Humanities, Durban.

Ramey, K. (2019). Should Cell Phones Be Allowed in School? Debate on Cell phones. https://www.useoftechnology.com/cell-phones-allowed-school-debate/.

Ramorola, M.Z. (2014). Challenge of effective technology integration into teaching and learning.

Africa Education Review, 10(4), 654-670.
https://doi.org/10.1080/18146627.2013.853559

Ramrathan, L. (2017). Educational research: Key concepts. In L. Ramrathan, L. Le Grange & P. Higgs (Eds). Education studies: For initial teacher development. 403-418. Juta & Co. (Pty) Ltd.

Ramrathan, L. (2021). School curriculum in South Africa in the COVID-19 context: An opportunity for education for relevance. Prospects (Paris), 51 (1-3), 383-392.

Ramrathan, P. (2017) Learner poor performance: Provoking Bourdieu's key concepts in analysing school education in South Africa. *Southern African Review of Education, 23(1):* 23-36.

Rathinaswamy, J., Sengottaiyan, K. & Duraisamy, B. (2020). A Qualitative Approach towards Adoption of ICT by Medical Doctors Applying UTAUT model. *Journal of Xi'an University of Architecture and Technology, 12(3),* 4689-4703.

Richards, L. & Morse, J.M. (2012). READMEFIRST for a User's Guide to Qualitative Methods (3rd ed.). SAGE Publishing.

Rithu, N. A., Rahman, M. & Al-Muruf, A. (2016). The status of Geography and Environmental Studies at Secondary Level Education in Bangladesh. *Archives of Current Research International, 5 (14),* 1–9.
https://doi.org/10.9734/ACRI/2016/29017

Roberts, M. (2017). Geography education is powerful. Teaching Geography (Spring 2017), 6-10.

Rogers, E. (2003). Diffusion of Innovations (5th ed.). Free Press.

Rogers, E.M. (2010). Policy diffusion dynamics in America (5th ed.). New York: Cambridge

University Press.

Rogošić, S. & Baranović, B. (2016). Social Capital and Educational Achievements: Coleman vs. Bourdieu. *C.E.P.S. Journal*, *6*(2). 81-100.

Sadeck, O. (2018). ICT integration and e-Learning. Western Cape Government. ICT integration and e-Learning. (westerncape.gov.za)

SAGE (2015). Dealing with Qualitative Questionnaire Data: Studying an Online Irritable Bowel Syndrome (IBS) Support Group. *SAGE Research methods Datasets Part 1*, 1-10.

Salehi, H., Shojaee, M. & Sattar, S. (2015). Using e-Learning and ICT Courses in Educational Environment: A Review. *English Language Teaching, 8 (1),* 63-70.

Salmons, J. (2014). *Qualitative Online Interviews: Strategies, Design, and Skills*. SAGE.

Salmons, J. (n.d.). Designing and Conducting Research with Online Interviews. https://www.betterevaluation.org/sites/default/files/43888_1.pdf

Sanders, S. & Schoeman, T. (2019). An Investigation into the State of Environmental Education and the Use of Technology in Environmental Education in Gauteng, South Africa. *17th Johannesburg International Conference on Education, Economics, Humanities and Social Sciences (EEHSS-19), November 18-19 JHB (SA).* https://doi.org/10.17758/EARES8,EAP1119442

Sands, D. & Garcia N. (2021). *What is Qualitative Observation?* Stucy.com What is a Qualitative Observation? | Definition and Examples - Video & Lesson Transcript | Study.com

Şanlı, C., Sezer, A. & Pinar, A. (2016). Perceptions of Geography Teachers to Integrating Technology to Teaching and their Practices. *Review of International Geographical Education Online* (*RIGEO*)*, 6*(3), 234-252.

Santos, G. M., Ramos, E. M., Escola, J., & Reis, M. J. (2019). ICT literacy and school performance. *Turkish Online Journal of Educational Technology, 18*(2), 19-39. https://eric.ed.gov/?id=EJ1211197

Sarfaraz, A. (2015). A note on the status of Geography teachers in Indian schools. *Geographical Education, 28*, 54-65.

Scheepers, D. (2009). GIS in the geography curriculum. GIS technical-Position IT, University of the Western Cape, 40-45.

Schmidt, D.A., Baran, E., Thompson, A.D., Mishra, P., Koehler, M.J. & Shin. T.S. (2009). Technological Pedagogical Content Knowledge (TPACK): The Development and Validation of an Assessment Instrument for Preservice Teachers. *Journal of Research on Technology in Education (JRTE), 42*(2), 123-149.

Schoeman, T. (2018). Training of Gauteng High School Teachers in Mapwork Skills. In A. Van der Waldt, N. Kotze, C. Barker and E. Kruger (2018). Proceedings of the Biennial Conference of the Society of South African Geographers, 1-5 October 2018. University of the Free State, South African.

Scholz, R. & Tietje, O. (2013). Embedded case study methods: Types of case studies. SAGE Publishers. https://doi.org/10.4135/9781412984027.n2

Segara, N.B., Maryani, E., Supriatna, N. & Ruhimat, M. (2018). Introducing Map Literacy Model of Learning. *1st UPI International Geography Seminar 2018: IOP Conf. Series: Earth and Environmental Science 145, 012046.* https://doi.org/10.1088/1755-1315/145/1/012046

Setterstrom, A.J., Pearson, M. & Orwig, R. (2013). Web-enabled wireless technology: an exploratory study of adoption and continued use intentions. *Behaviour and Information Technology, 32*(11), 1139-1154. http://dx.doi.org/10.1080/0144929X.2012.708785

Shah, S.A. (2013). Making the Teacher Relevant and Effective in a Technology-Led Teaching and Learning Environment. Procedia Social and Behavioural Sciences, 103, 612-620. https://doi.org/10.1016/j.sbspro.2013.10.379

Shambere, R. (2014). The Adoption of WhatsApp: Breaking the Vicious Cycle of Technological Poverty in South Africa. *Journal of Economics and Behavioural Studies, 6(7),* 542-550. https://doi.org/10.22610/jebs.v6i7.515

Shamle, H., Henry, U.A., Bulus, D.I. & Tsebe, J.S. (2022). Solutions to challenges confronting geography teachers' effectiveness in secondary schools in Akwanga Local Government Area of Nasarawa State, Nigeria. *International Journal of Advanced Academic Research (IJAAR), 8*(4), 1-9. https://doi.org/10.46654

Shar, S.A. (2013). Making the Teacher Relevant and Effective in a Technology-Led Teaching and Learning Environment. *Procedia - Social and Behavioral Sciences, 103*, 612-620.

Shepherd, I.D.H. (1985). Teaching Geography with the Computer: Possibilities and Problems. *Journal of Geography in Higher Education, 9*(1), 3-23.

Simplilearn. (2021). What is Data Analysis: Methods, Process and Types Explained. **https://www.simplilearn.com/data-analysis-methods-process-types-article**

Smith, J. & Arendse, A. (2016). South African Curriculum Reform: Education for Active Citizenship. *BCES Conference Books, 14(1),* 65-72.

Solemn, M., Stoltman, J., Lane, R., Bourke, T., Chang, C.H. & Uehrig, K. (2018). An

Assessment Framework and Methodology for a Trend in International Geography. Assessment Studies (TIGAS). *Geographical Education*, *31*, 7-15.

Liu, G.-Z. (2010). Book review: Handbook of Research on Educational Communications and Technology (Eds. J. M. Spector, M. D. Merrill, J. van Merrienboer, & M. P Driscoll). *Educational Technology & Society, 13*(1), 260-263.

STANDS4 LLC. (7 Dec. 2021). Sampling frame. Web. https://www.definitions.net/definition/Sampling+frame

Stošić, L. (2015). The Importance of Educational Technology in Teaching. *International Journal of Cognitive Research in Science, Engineering and Education (IJCRSEE) 3(1)*, 111-114.

Sullivan, M. (2017). Personality types and acceptance of technical knowledge management systems (TKMS).

Sumak, B., Polancic, G., & Hericko, M. (2010). An empirical study of virtual learning environment adoption using UTAUT. Second International Conference on Mobile, Hybrid, and On-Line Learning, St Maarten, Netherlands Antilles, 17–22. https://doi.org/10.1109/eLmL.2010.11

Sutar, A.P., S. S. Bhosale, S.S., & Pujari, V.I. (2019). ICT in education systems. *Journal of Emerging Technologies and Innovative Research (JETIR), 6*(5), 106 – 109.

Taherdoost, H. (2016). Sampling Methods in Research Methodology: How to Choose a Sampling Technique for Research. *International Journal of Academic Research in Management, 5*(2), 18-27.

https://www.researchgate.net/publication/319998246_Sampling_Methods_in_Research_Methodology_How_to_Choose_a_Sampling_Technique_for_Research/

Tapan, S.M. (2009). Using ICT in Teaching – Learning at Polytechnic Institutes of Bangladesh:

Constraints and Limitations. *Teachers World Journal of Education and Research, 33*(34), 207-217.

Taylor, J. (2020). Should Smartphones be Allowed in Schools? https://www.essaytyping.com/should -smartphones-be-allowed-in-schools/

Telkom (2015). Technology in Education: Considerations and Trends for the Education Sector.

Theofanidis, D. & Fountouki, A. (2019). Limitations and Delimitations in the Research Process. *Perioperative Nursing (GORNA)*, *7*(3), 155-162.

Thomas, D., Singh, L. & Gaffar, K. (2013). The utility of the UTAUT model in explaining mobile learning adoption in higher education in Guyana. *International Journal of Education and Development using Information and Communication Technology, 9(3),* 71-85.

Tornatzky, L. G. & Fleischer, M. (1990). The processes of technological innovation, Lexington books, Lexington, MANo Title.

Trepule, E., Tereseviciene, M. & Rutkiene, A. (2014). Didactic Approach of Introducing Technology-Enhanced Learning (TEL) Curriculum in Higher Education. *Procedia Social Behavioral Science, 191*, 848-852.

Trucano, M. (2018). A new research hub on the use of technology in education in developing countries. http://blogsworldbank.org/team/michael-trucano

Tschannen-Moran, M., & Hoy, A. (2001). Teacher efficacy: capturing an elusive construct. *Teaching and Teacher Education*, 783–805.

Tsibonane, P. & Kunene, K. (2017). To Ban or Not to Ban: Uses and Gratifications of Mobile Phones Among Township High School Learners. *African Conference on Information Systems & Technology. University of Cape Town, 10-11 July 2017*.

Turpin, M. (2018). Assessing South African ICT4D research outputs: A journal review. *South*

African Computer Journal 30(1), 108–127. https://doi.org/10.18489/sacj.v30i1.541

Turzin, H., Yilmaz-Soylu, M., Karakus, T., Inal, Y. & Kizilkaya, G. (2008). The effects of computer games on primary school students' achievement and motivation in geography learning. *Computer Education*, *52*(1), 68-77.

UNESCO-Institute of Statistics (UIS). (2011). Information and Communication Technology (ICT) in Education I Sub-Saharan Africa: comparative analysis of basic e-readiness in schools. Open Access.

UNESCO-KFIT (2019). ICT Transforming Education in Africa. UNESCO-KFIT Project https://en.unesco.org/themes/ict-education/kfit

UNESCO. (2018). SDG4 Data Digest: Data to Nurture Learning. UNESCO Institute for Statistics.

UNESCO (2015). ICT in Education in Sub-Saharan Africa: A comparative analysis of basic e-readiness in schools. Information Paper No. 5. Open Access. UNESCO Institute for Statistics. https://dx.doi.rog/10.15220/978-92-9189-178-8-en

UNESCO-UIS. (2014, March). *Guide to measuring information and communication technologies (ICT) in education.* http://unesdoc.unesco.org/images/0018/001865/186547e.pdf

UNESCO-OER. (2019). ICT competency Framework for Teachers: Harnessing open educational resources. En.unesco.org/themes/ict-education/competency-framework-teacher-oer

Utama, C., Sajidan, Nurkamto, J. & Wiranto (2019). Using TPACK as a framework to analyze TLC model. *Journal of Physics Conference series 2019*, 1-6. https://doi.org/10.1088/1742-6596/1175/1/012146

Valasidou, D., Sidiropoulos, T., Hatzis, D. & Bousiou-Makridou, (2005). Guidelines for the Design and Implementation of e-Learning Programmes, Proceedings of the IADIS. *International Conference IADIS E-Society 2005, 27-30 June*, Qawra, Malta.

Van As, F. (2018). Communities of Practice as a tool for continuing professional development of technology teachers' professional knowledge. *International Journal of Technol Des Educ*, *28*, 417-430.

Van der Merwe, E, (2016). Connectivity now: Why internet access in Africa is more vital than ever. Nelson Mandela-Rhodes Foundation. https://www.mandelarhodes.org/news-impact/yam/connectivity-now-why-internet-access-in-africa-more-vital-than-ever/ Accessed November 2022.

Van der Waldt, G. (2020). Constructing conceptual frameworks in social science research. The *Journal of Transdisciplinary Research in Southern Africa, 16*(1). 758. https://doi.org/10.4102/td.v16i1.758

Connectivity now: Why internet access in Africa is more vital than ever — Young African Magazine | The Mandela Rhodes Foundation

Van Greunen, D., Kativu, K., Veldsman, A. & Botha, J. (2021). Enhancing ICT readiness of schools in South Africa. DST Policy Post DocuSignEnvelope ID. DBD705EF-E80F-43A5-84F5-385D9BF471DD.

Vassallo, S. & Warren, D. (2018). *Use of technology in the classroom*. LSAC Annual Statistical Report 2017. ResearchGate.

Vatanartiran, S & Karadeniz, S. (2015). A Needs Analysis for Technology Integration Plan: Challenges and Needs of Teachers. *Contemporary Educational Technology, 6*(3), 206-220.

Vaughn, S., Schumm, J. & Sinagub, J. (1996). Focus group interviews in education and psychology. SAGE Publications. https://www.doi.org/10.4135/97814522433641

Venkatesh, V., Morris, M. G., Davis, G. B. & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Q. 27*(3), 425–478.

Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly, 36*(1), 15.

Vodacom (2019). Connecting ICT to education. Bizcommunity. https://www.bizcommunity.com

Voogt, J. & McKenny, S. (2017). TPACK in teacher induction: Are we preparing teachers to use technology for early literacy? *Technology, Pedagogy and Education, 26*(1), 69-83. https://doi.org/10.1080/1475939x.2016/1174730

Vota, W. (2021). ICT works. https://wwww.ictworks.org/edutech-innovations-south-africa-learning.#.Y;CnKYaBzrc

Wach, E. (2013). Learning about Qualitative Document Analysis. IDS Practice Paper. (PDF) Learning about Qualitative Document Analysis (researchgate.net)

Walden, G. R. (2012). Focus Group Research: Benchmarks in Social Research Methods. SAGE

Walker, R., Voce, J., & Ahmed, J. (2012). Survey of Technology-Enhanced Learning for Higher Education in the UK. Oxford: University and Colleges Information Systems Association.

Wang, Q. (2008). A generic model for guiding the integration of ICT into teaching and learning, *Innovations in Education and Teaching International, 45*(4), 411-419. https://doi.org/10.1080/14703290802377307

Wang, C., Kantor, C.M., Mitchell, J.T. & Bacastow, T.S. (2020). Chapter 24: Digital Earth Education. Accessed from http://creativecommons.org/licenses/by/4.0/

Webb, M., Bell, T., Davies, N., Katz, Y., Reynolds, N. et al. (2017). Computer Science in the School Curriculum: Issues and Challenges. *11th IFIP World Conference on Computers in Education (WCCE), July 2017, Dublin, Ireland.* 421-431. https://doi.org/10.1007/978-3-319-74310-3_43

Western Cape Government Directorate. (2018). Guidelines on cellular phones and other mobile technologies in public schools, 2018. E-Learning Directorate, Western Cape, SA.

Whiting, B. (2021). *What is Data Analysis? Definition & Overview*.
What is Data Analysis? - Definition & Overview - Video & Lesson Transcript | Study.com

Wibowo, M.P. (2019). Technology Acceptance Models and Theories in Library and Information Science Research. Library Philosophy and Practice (e-journal), 3674. https://digitalcommons.unl.edu/libphilprac/3674

Wieking, B. A. (2016). Technology integration and student learning motivation. Master's thesis, North-Western College, Orange City, IA.

Wigglesworth, J. (2003). What is the best Route Finding Strategy of Middle School Students using GIS. *Journal of Geography*, *102*(5), 282-291.

Williams, M. & Moser, T. (2019). The Art of Coding and Thematic Exploration in Qualitative Research. *International Management Review*, *15*(1), 45-55.

Wilmot, P.D. & Dube, C. (2016). Opening a window onto school geography in selected public schools in the Eastern Cape province. *South African Geographical Journal*, *8*(2), 337-350.

Wisegate IT. (2017). Sample Corporate Mobile Device Acceptable Use and Security Policy. Retrieved from Wisegate IT.
http://wisegateit.com/resources/downloads/wisegate-sample-byod-policy.pdf

Woolbridge, J. (2004). Technology integration as a transforming teaching strategy. https://www.techlearning.com/news/technology-integration-as-a-transforming-teaching-strategy

Woolcock, M, & Narayan, D. (2000). Social Capital: Implications for Development Theory, Research and Policy. The World Bank Research Observer.

Xie, M. (2019). Rethinking Map Literacy and an Analysis of Quantitative Map Literacy. Graduate Theses and Dissertations. https://scholarcommons.usf.edu/etd/7989

Yin, R.K. (2013). Case Study Research: Design and Methods, Fourth Edition, Applied Social Research Methods, Volume 5, Sage Publications Incorporated

Annexure 1

UNIVERSITY OF TM
KWAZULU-NATAL
INYUVESI
YAKWAZULU-NATALI

04 May 2021

Mr Nkanyezi Hills Cele (201504875)
School Of Education
Edgewood Campus

Dear Mr Cele,

Protocol reference number: HSSREC/00002460/2021
Project title: A Case Study of Geography Teachers' Use of Technology in the Teaching of Mapwork Calculations in a Secondary School in KwaZulu-Natal
Degree: PhD

Approval Notification — Expedited Application

This letter serves to notify you that your application received on 11 December 2020 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 04 May 2022.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/dd

Humanities and Social Sciences Research Ethics Committee
Postal Address: Private Bag X54001, Durban, 4000, South Africa
Telephone: +27 (0)31 260 8350/4557/3587 Email: hssrec@ukzn.ac.za **Website**: http://research.ukzn.ac.za/Research-Ethics
Founding Campuses: **Edgewood** **Howard College** **Medical School** **Pietermaritzburg** **Westville**

INSPIRINGGREATNESS

Annexure *2*

KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

OFFICE OF THE HEAD OF DEPARTMENT

Private Bag X9137, PIETERMARITZBURG, 3200 Anton Lembede Building, 247 Burger Street, Pietermaritzburg, 3201 **Email**: Phindile.duma@kzndoe.gov.za **Tel**: 033 3921062 / 033-3921051 Buyi.ntuli@kzndoe.gov.za

Enquiries: Phindile Duma/Buyi Ntuli **Ref.**:2/4/8/7041

[redacted]

Mr Nkanyezi Hills Cele
W 1123 Pioneer Park
P.O. Umlazi
4066

Dear Mr Cele

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"A CASE STUDY OF GEOGRAPHY TEACHERS' USE OF TECHNOLOGY IN THE TEACHING OF MAPWORK CALCULATIONS IN A SECONDARY SCHOOL IN KWAZULU-NATAL** in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 03 November 2020 to 10 January 2023.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Phindile Duma/Mrs Buyi Ntuli at the contact numbers above.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

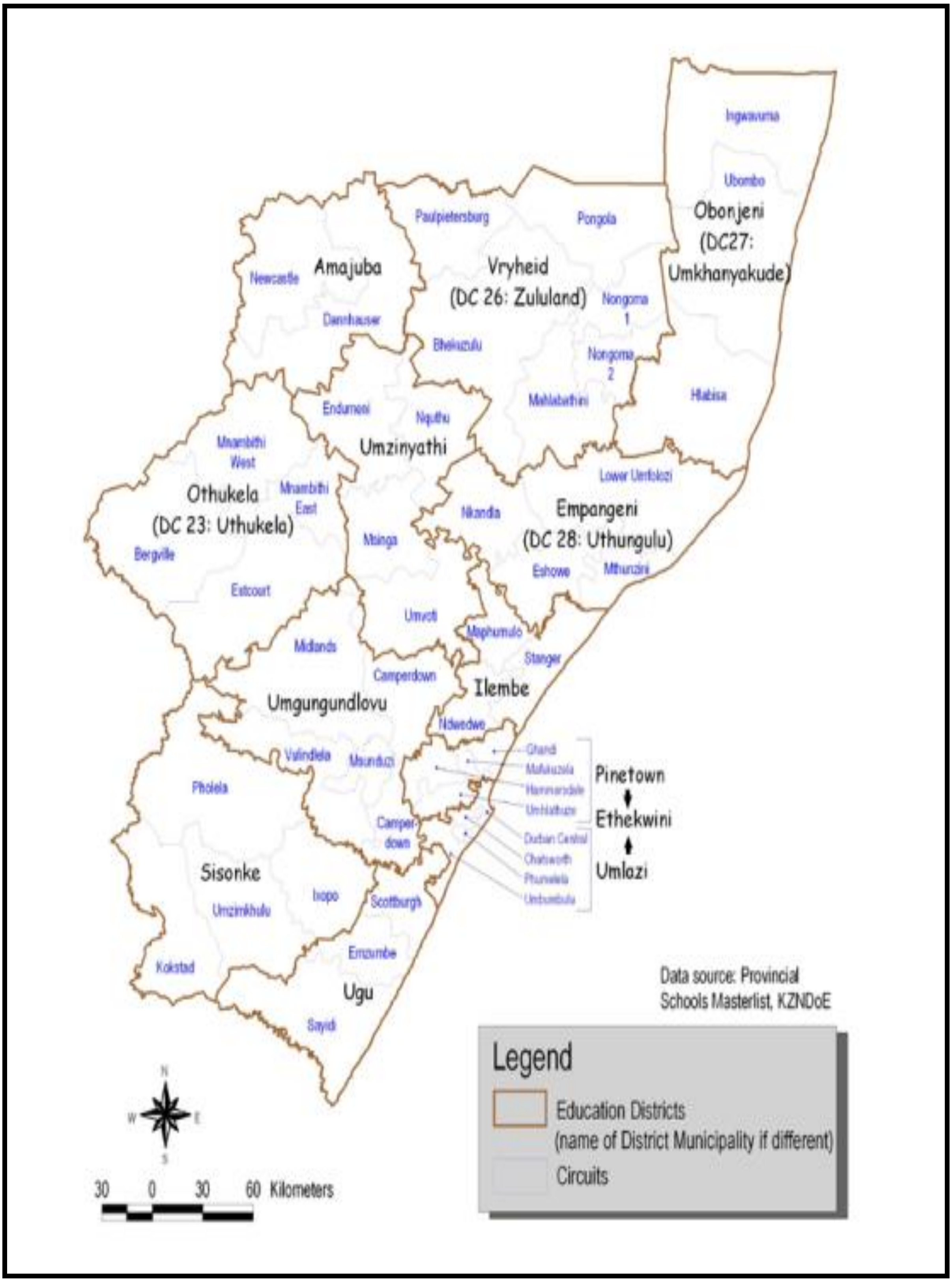
[redacted]

Dr. EV Nzama

Head of Department: Education Date: 03 November 2020

GROWING KWAZULU-NATAL TOGETHER

Annexure 3



Map of KwaZulu-Natal Education Districts, South Africa [Adapted from Ajibade and Bertram, 2020]

Appendix A

UKZN HUMANITIES AND SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE (HSSREC)

APPLICATION FOR ETHICS APPROVAL

For research with human participants

INFORMED CONSENT

Information Sheet and Consent to Participate in Research

Date: 19 May 2021

Greetings

My name is Nkanyezi Hills Cele. I am a PhD student from the School of Education at the University of KwaZulu-Natal's Edgewood campus.

You are being invited to consider participating in a study that involves research in geography teachers' integration of technology in the teaching of mapwork calculations at secondary schools in KwaZulu-Natal. The purpose of this research is to explore the extent of the use of technology in teaching mapwork calculations in Grade 10 geography education, and the implications of teaching this aspect in the way that they do.

The study is expected to enrol 120 participants from schools in one education district of KwaZulu-Natal. While observing COVID-19 regulations, data will be collected by means of an electronic questionnaire, where possible, except for one site where interviews will be conducted with participant (s) face-to-face, telephonically or via Zoom. The study will involve qualitative questionnaires from various sites, focus groups as well as individual interviews with participants at a single site. The duration of your participation, should you choose to enrol and remain in the study, is expected to be less than twenty minutes. The study is funded by the researcher.

The study does not involve any risks and/or discomfort. We hope that the study will entrench, the integration of technology in the teaching of geography mapwork calculations at the research site, the circuit, and ultimately the KwaZulu-Natal province and countrywide. The findings of this research will contribute to a more practical approach to the development and the use of appropriate applications that will assist in the teaching and learning of geography mapwork calculations at secondary schools within the circuit, province and countrywide.

This study has been ethically reviewed and approved by the UKZN Humanities and Social Sciences Research Ethics Committee (approval number: HSSREC/00002460/2021).

In the event of any problems or concerns/questions you may contact the researcher at 201504875@stu.ukzn.ac.za, (Private email: nkanyezicele843@gmail.com) cell number: 0768720785 or the UKZN Humanities & Social Sciences Research Ethics Committee, contact details as follows:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001

Durban

4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557- Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

Your participation in this study is purely voluntary and does not bear any financial costs. By participating, you are granting the researcher permission to use your responses. You may refuse to participate without any obligation or withdraw from the study at any time with no negative consequence. There will be no monetary gain from participating in the study. Your anonymity will be maintained by the researcher and the Human and Social Science Research Ethics Committee. Your responses will not be used for any purposes outside of this study.

All data, both electronic and hard copy, will be securely stored during the study and archived for a period of 5 years. After this time, all data will be destroyed. If you have any questions or concerns about participating in the study, please contact me or the Research Ethics Committee at the contact details provided above.

Yours faithfully

Nkanyezi Cele

Appendix B

University of KwaZulu-Natal

Edgewood Campus

Private Bag x 03

Ashwood

3605

18 March 2020

The Principal

Night Owl Secondary School

P. O. Box 36230

NTOKOZWENI

4066

Dear Sir/Madam

RE: Conducting scholarly research at your school

I hereby request your permission to conduct scholarly research with your teacher/s who teach Geography to Grade 10 classes. I will visit your school on particular days that we may agree upon with the participant/s in the project, and conduct classroom observations, document analysis as well as semi-interviews with the geography teacher/s. The study will assist your teacher/s to gain a better understanding of the integration of ICT (technology) in the teaching geography mapwork calculations.

I am currently studying for the qualification of Doctor of Philosophy in Education at the University of KwaZulu-Natal Edgewood Campus, specialising in Curriculum Studies. I am exploring the integration of technology in the teaching of geography mapwork calculations. The study follows a case study methodology where Grade 10 geography teachers will be asked to participate in qualitative methods (semi-structured interviews, focus groups, observations and document analysis) of data collection. Your teachers will also be requested to respond to a questionnaire that will be disseminated in the geography clusters of the district.

I promise that the information elicited from the participant/s will be treated with confidentially and anonymity. Furthermore, their autonomy will be observed. Should you have questions regarding this matter, please contact me on the above address or on the following numbers:

Cell. No.: 076 872 0785

067 956 1816

Email: nkanyezicele8432gmail.com

or

UKZN email: 201504875@stu.ukzn.ac.za

For further verification on this matter, I refer you to my supervisor, Dr V. Paideya as follow:

UKZN (Westville Campus)

Chemistry & Physics Building – H block

Room 043, 3rd Floor

CONTACT DETAILS: Tel. No.: (031) 260 8311

Email: paideya@ukzn.ac.za

I am looking forward to your kind co-operation in this matter. Thanking you in anticipation.

Yours faithfully

Mr N. H. Cele

Appendix C

PARTICIPANT'S INFORMED CONSENT

I, ____ have been informed about the study entitled 'Geography Teachers' Integration of Technology in the Teaching of Mapwork Calculations in a Secondary School in KwaZulu-Natal' by Nkanyezi Hills Cele.

I understand the purpose and procedures of the study to explore the use of technology in teaching mapwork calculations in Grade 10 Geography education, and the implications of teaching this aspect in the way that they do.

I have been given an opportunity to answer questions about the study and have had answers to my satisfaction. I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without affecting any of the benefits that I usually am entitled to.

If I have any further questions/concerns or queries related to the study, I understand that I may contact the researcher at 201504875@stu.ukzn.ac.za Cell number: 076 872 0785.

If I have any questions or concerns about my rights as a study participant, or if I am concerned about any aspect of the study or the researcher then I may contact:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001

Durban

4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557 - Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

Additional consent, where applicable,

I hereby provide consent to:

Audio-record my interview / focus group discussion YES / NO

Video-record my interview / focus group discussion YES / NO

Use of my photographs for research purposes YES / NO

______________________________ ______________________________

Signature of Participant Date

______________________________ ______________________________

Signature of Witness (Where applicable) Date

Appendix D **QUESTIONNAIRE**

SCHOOL:____

MALE ☐ FEMALE ☐ PREFER NOT TO SAY ☐

NATURE OF EMPLOYMENT: PERMANENT ☐ TEMPORARY ☐

EXPERIENCE IN TEACHING GEOGRAPHY: 0 -5 YEARS ☐ 6 – 10 YEARS ☐

11 – 15 YEARS ☐ 16 – 20 YEARS ☐

21 – 25 YEARS ☐ 26 AND OVER ☐

Title: Exploring Geography Teachers' Professional Use of Technology in the Teaching of Mapwork Calculations in a Secondary Schools in KwaZulu-Natal.

How do geography teachers use technology to enhance the effective teaching of mapwork calculations?

How often do you teach mapwork calculations?	Everyday/ Weekly	Every Month	Once per term	Once per year	Only before a test/exam	Other

PLACE A TICK (√) IN THE APPROPRIATE COLUMN	**YES**	**NO**
Do you have a computer/laptop of your own?		
Do you have any of the following? Smart-phone		
i-phone		
tablet		
Do you have personal access to the internet?		
Does your school provide an internet (Wi-Fi) connection?		
Do you have a geography laboratory at your school?		
Do you have access to the science laboratory or science equipment/apparatuses?		
Do you have access to any school computer, e.g., communal computers or computers reserved for CAT learners?		
Does your school have an overhead projector (OHP)?		
Do you have an internal subject committee in your school?		
Have you received any training in using ICT (Information Communication Technology)?		

USE THE OPTION THAT SUITS YOUR SITUATION/EXPERIENCE (Mark with a **√** tick)	**Excellent**	**Good**	**Average**	**Weak**
How do you rate your computer expertise? Word processing				
Spread sheet				
Internet browsing				
Programming				
Presentation tools (Power point)				
Downloading tools/resources for geography teaching and learning				

Designing your lesson plan using any of the technological devices (smartphone/iPhone/tablet/computer, etc.)				

The efficacy of using technology to teach mapwork calculations in Geography education.

Why do geography teachers in secondary schools teach mapwork calculations the way they do?

USE THE OPTION THAT SUITS YOUR SITUATION/EXPERIENCE (Mark with a **√** tick)	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
I can prepare lessons that involve the use of ICT by learners				
I know which teaching and learning situations are suitable for ICT use in Geography				
I can find useful curriculum resources for Geography on the internet/smartphone				
I can use the internet to support the teaching and learning of geography mapwork				
I can use a computer in monitoring learners' progress in Geography				
I can use computer applications in teaching certain geographic aspects/themes				
I can use ICT in giving effective presentation/explanations				
I can use ICT to communicate with other teachers				
I can teach geographic mapwork calculations using technological devices (ICT tools) such as the computer, OHP, videos, slides, mobile phones, etc.				
I can use electronic maps to teach mapwork calculations and map interpretation to my learners				

Strategies of how mapwork calculations can be taught more effectively in secondary schools using technology.

What implications does technology have for geography teaching and learning?

USE THE OPTION THAT SUITS YOUR SITUATION/EXPERIENCE (Mark with a **√** tick)	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
The school has sufficient maps (hard copies) for teaching and learning				
I use 2-Dimensional maps to teach calculations and interpretation				
I re-arrange the class to form groups when teaching mapwork calculations and interpretation				
I allow the use of calculators when teaching mapwork				
I allow the use of smartphones/mobile phones when teaching mapwork				
I encourage discussion among learners when teaching mapwork				
I exchange groups (swap group members) for each lesson on mapwork calculations and interpretation				
My learners understand better when taught in groups				
I assess learners on mapwork calculations and interpretation while they are seated in their groups				

Teachers' experiences in the use of ICT in geography teaching and learning.

USE THE OPTION THAT SUITS YOUR SITUATION/EXPERIENCE (Mark with a **√** tick)	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
Digital literacy in geography teaching and learning is an important skill.				
Geography teachers must be trained in how to integrate ICT tools into their daily teaching activities.				
Computer science training must be integrated in the geography national curriculum .				
Teachers need to expose learners to basic science and thinking innovatively from a young age.				
Computers will only add to the workload of geography teachers.				
Capable/experienced teachers do not need ICTs to teach mapwork efficiently.				
Using ICTs can hamper my creativity skills in teaching geography mapwork.				
Professional development with regard to the use of ICTs in teaching geography mapwork is a waste of time.				
Knowing how to integrate ICT is a worthwhile skill				
ICTs are necessary to raise learners' interests and to encourage good performance in geography mapwork.				
I feel tense and uncomfortable when using ICT tools to teach geography mapwork.				
Using ICT makes me more flexible and innovative in teaching geography mapwork.				
I know the software applications to teach Geography, as proposed by the DBE.				
I use the software applications in my teaching of Geography.				
I know nothing about the software applications for geography teaching.				

These are some of the things that make geography teaching frustrating/enjoyable at times:

____

____

____

The integration of ICTs (technological tools) in Geography is made possible/hindered by the following:

____

____

____

This is important to improve the teaching of mapwork calculations:

____

____

____

Appendix *E*

FOCUS GROUP DISCUSSION

Welcoming address & Ethics

- Thank you for agreeing to participate in this discussion.
- I am interested in knowing your experiences and attitudes about the integration of Technology in the teaching of geography mapwork calculations
- I am going to ask a few questions about this aspect
- NOTE that I will not be contributing to the discussion, but I will moderate the session by keeping track of time and ensure that all issues are discussed.
- I will record the session, so, please loud and clearly so I can record everything you say. *Do not speak over each other.*
- All ethical protocol will be observed (confidentiality, autonomy, honesty, etc.)

•What are your experiences in teaching mapwork calculations? Do you feel at ease when teaching this aspect or do you experience some difficulties? Please explain, how?

•What competencies do you have in the use of technology in the classroom?

•How does the use of technology influence your lesson planning for the teaching of geography mapwork?

•How does the use of technology affect your pedagogic practice in the classroom in terms of learner participation?

•Does the use of technology practically improve the learner pass rate? If so, how?

•Do you feel you have adequate professional support in attempting to integrate technology into your teaching of mapwork calculations? Please, explain why.

THANK YOU……..

Appendix F

Semi-structured Interview Questions

TEACHER'S BIOGRAPHICAL INFORMATION

SCHOOL: Night Owl Secondary DATE: 25 August 2021 TIME: 17:00

TEACHER: Mrs Mpanza SEX: Female

Instruction: Mark with a tick (√) in the appropriate box.

Academic qualification/s in Geography

MATRIC	DIPLOMA	DEGREE √	HONOURS √	MASTER	PHD

Professional training in Geography teaching methodology

PGCE	DIPLOMA	HDE	DEGREE	OTHER

Employment status

PERMANENT √	TEMPORARY	SGB POST

Other subjects you teach

SUBJECT	GRADE	SUBJECT	GRADE	SUBJECT	GRADE

Experience in teaching Geography?

NO. OF YEARS	1 - 5	6 - 10	11 - 15	16 - 20	21 - 25	26 - 30
FET PHASE (Grades 10 – 12)						√
SENIOR PHASE (Grades 7 – 9)						
INTERMEDIATE PHASE (Grades 4 – 6)						
FOUNDATION PHASE (Grades 1 – 3)						

1. Can you tell me a little about yourself in relation to the work you do?

2. When did you begin to teach in this school?

3. How were you selected to teach the subject? (If not specialised in the subject)

4. What interest you the most? Which aspects (themes) do you like the most in your teaching of the subject? – (The Atmosphere, Geomorphology, Geographical skills and Techniques, Population Geography, Water Resources)

5. Why do you like to teach this theme?

6. What do you consider to be your greatest professional strengths? Why?

7. What do you consider to be your weaknesses? Why?

8. What do you think needs to be done to address them?

9. What resources are available in your Dept for improving teaching and assessment techniques?

10. Do you have rewards in the school for innovative teaching/learning and assessment strategies?

11. What are some of the challenges your Dept face in attempting to change teaching/learning and assessment practices?

____
____
____

12. How far have you tried to integrate ICTs in your teaching of Geography?

____
____
____

13. Can you tell me more about your geography cluster/s in this district?

____
____
____
____

14. What support do you receive from the subject advisor(s) in terms of workshops, training or personal visits?

____
____
____

15. Have you ever dealt with the annual Diagnostic Reports in your cluster meetings? How do you intend to address the problems that have been diagnosed?

____
____
____

16. How often do you teach geography mapwork?

____
____

17. What is your experience in teaching mapwork to your learners? Do your learners find it easy to follow all the calculation steps when teaching?

i. Magnetic Declination? (e. g. MD Calculator, Topographic maps)

ii**.** Bearing (YouTube videos, Protractors)

iii. Real distance (e.g., time travelled by cyclist over a certain distance)

iv. Gradient (VI/HE or VD/HD – YouTube, Calculators, map and ruler)

v. Height (Trig. Beacon; spot height; benchmark; contours) = (Smart Measure; M. Height; clinometer; Gabriel Hemery/GH Method)

vi. Grid reference/Coordinate system (YouTube; Heath Smith Method; OS Map Skills)

____
____
____
____
____
____

18. Why do you think learners have the problems you have just mentioned?

____
____
____

19. How do you intend to address the problems you experience with your learners in this aspect?

____
____
____
____

20. How do you advise your learners to interpret physical, orthophoto and topographical maps in terms of the following:
(slopes, landforms, artefacts, etc. using texture, tone and shape)

____
____
____

21. What do you think causes the problem you have just mentioned?

____
____
____

22. How do you intend to address these problems?

____
____

23. Are there any technological devices (computers, OHP, mobile phone, etc.) that you employ in preparation for your lessons?

____
____

24. How do you communicate with your colleagues in the geography cluster

____
____
____

25. Do you think ICTs can make your work easier when teaching geography mapwork? How?

____
____
____

26. Does the school have access to the internet?

____
____
____

27. How would you feel if Geography textbooks were only available on-line?

____
____
____

28. Would you be comfortable to use maps that are available on-line, e.g., Google-maps, instead of the hard copies you currently use?

____
____
____

29. Would you recommend the use of mobile phones to assist in the teaching of geography mapwork?

____
____
____

30. Do you feel there is a need for capacitation in using ICTs when teaching mapwork?

____
____
____

31. Why do you think so?

____
____
____

32. Do you consider the professional development workshops to be fruitful for geography teachers, particularly on mapwork?

____
____

33. If you were given the opportunity to implement improvement strategies in the Grade 10 Geography programme, would you recommend the use of ICT software? Why?

____
____
____

34. Considering mapwork calculations, which aspect/s do you perceive to be difficult to use ICTs in for your learners?

____
____
____

35. What else would you improve in the environment where you are currently teaching?

____
____

36. Some of the problems you mentioned are systemic, what would you suggest to the Departmental officials to change the *status quo*, and why?

____
____
____

37. Do you think technology has a role when liaising with your colleagues in Geography education?

____
____
____

38. Do you think that the use of technology can improve the teaching of geography mapwork in particular? Why do you think so?

____
____

……………………………………….THANK YOU…………………………………..

Appendix G

FACTOR	MEASURE	EVIDENCE	COMMENT
LEADERSHIP	Is there evidence of structures, fora or committees to facilitate innovative teaching and learning of Geography and/or Social Sciences in general, in the FET phase?	What are they? How often? Where? Who is involved?	
PROFESSIONAL DEVELOPMENT	Is there a schedule of Prof. Dev. sessions for Geography teachers available? Is this well-attended and supported by staff? Are there opportunities for peer learning?	Yes ☐ No ☐ Yes ☐ No ☐ Partly ☐ Yes ☐ No ☐	
INSTRUCTIONAL GUIDANCE	Is there any evidence of internal planning regarding innovative teaching and learning of Geography and other social sciences? Is there any evidence of planning by cluster schools?	What evidence is available?	

STRUCTURAL FACTORS	What is the average class size? Are all Geography classes roughly the same size and capacity? Does the school have a Geography laboratory? Yes ☐ No ☐ Is there any evidence of the utilisation of latest technology like OHP/ Computers? Yes ☐ No ☐ Do students have access to technology for Geography lessons?	Who is eligible to use them? Teachers only ☐ All learners ☐ CAT learners only ☐ everybody ☐	
PHYSICAL RESOURCES	Is there any evidence of the existence and use of textbooks? Is an online Geography textbook made available? Does the school have physical maps? (Orthophoto and topographical maps, wall maps and (a) globe/s) Yes ☐ No ☐ How are mapwork calculations done?	Yes ☐ No ☐ Yes ☐ No ☐ Yes ☐ No ☐ Use of technology? Yes ☐ No ☐ Physical maps? Yes ☐ No ☐ Use of both technology and physical maps? Yes ☐ No ☐	

Appendix H

Technology integration:

What the Learning Outcome does the lesson aim to achieve?

What will the learners be able to do at the end of the lesson?

What technological skill/s are addressed in this lesson/project?

What resources are available in the classroom?

How was/were the resource/s used in the lesson?

What can be improved in the lesson?

Any other comment:

____

Appendix I

DOCUMENT ANALYSIS (School: Night Owl Secondary School)

1. What documents are available to teach Grade 10 Geography?

_______________________________ ____________________________________

_______________________________ ____________________________________

2. How many assessments in mapwork have been carried out in relation to CAPS requirements?

________________________ _________________________ _____________________

________________________ _________________________ _____________________

3. How is the general response to assessments assigned to learners?

Completed ☐ partially completed ☐ incomplete ☐

4. How is the general performance in all assignments/tests/projects presented in class?

Tests: Excellent ☐ Good ☐ Poor ☐ Very weak ☐

Assignments: Excellent Good ☐ Poor ☐ Very weak ☐

Projects: Excellent ☐ Good ☐ Poor ☐ Very weak ☐

5. Attendance: Excellent ☐ Good ☐ Poor ☐ Very weak ☐

(According to the register)

Comment:

____

____

5.1 What strategy is used to eliminate poor attendance, if any?

____

____

5.1 What positive reinforcement is applied to encourage proper attendance?

____

6. Learner portfolio: Which one/s is/are available?

Exercise-book ☐ File ☐ Textbooks ☐ Study guide ☐

7. What other strategies are used to complement classroom activities?

Field trips ☐ Library assignments ☐ Electronic media ☐

8. What type of technology does the teacher use to complement classroom activities?

____

9. How do learners respond to the activities presented online or using technological devices?

Excellent ☐ Good ☐ poor ☐ Very weak ☐